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COORDINATES OF FEATURES ON THE CALILEAN SATELLITES

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COORDINATES OF FEATURES ON THE GALILEAN SATELLITES

Merton E. Davies and Frank Y. Katayama

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PREFACE

Development of control nets for the four Galilean satellites began shortly after the two Voyager spacecraft flybys of Jupiter in 1979. A preliminary report on the progress of the control nets was published in November 1979 (R-2532-JPL/NASA). This updated report will be published in the *Journal of Geophysical Research*. The work is supported by the Jet Propulsion Laboratory and the National Aeronautics and Space Administration. The results are of primary interest to planetary cartographers.

SUMMARY

Control nets of the four Galilean satellites have been established photogrammetrically from pictures taken by the two Voyager spacecraft during their flybys of Jupiter in 1979. Coordinates of 504 points on Io, 112 points on Europa, 1547 points on Ganymede, and 439 points on Callisto are listed. Selected points are identified on USGS maps of the satellites. Measurements of these points were made on 234 pictures of Io, 115 pictures of Europa, 282 pictures of Ganymede, and 200 pictures of Callisto. The systems of longitude were defined by craters on Europa, Ganymede, and Callisto. Preliminary solutions have been found for the directions of the axes of rotation of the Galilean satellites. New mean radii have been determined as 1815 ± 5 km for Io, 1569 ± 10 km for Europa, 2631 ± 10 km for Ganymede, and 2400 ± 10 km for Callisto.

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ACKNOWLEDGMENTS

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The maps used in the figures were prepared by the USGS, Flagstaff, under the direction of Raymond M. Batson. Patricia M. Bridges (Io and Callisto) and Jay L. Inge (Europa and Ganymede) made the surface interpretations and beautiful airbrush renditions.

James A. Roth, Thomas A. Hauge, and David Douglass of Rand were responsible for the selection, identification, and measurements of the control points on the individual pictures. We are appreciative of their dedication and care in carrying out this important part of the work. We thank Thomas C. Duxbury of JPL and Laurence A. Schimerman of the Defense Mapping Agency, Aerospace Center, for review and constructive comments on a draft manuscript. This task was carried out at Rand under JPL Contract No. 953613 and NASA Contract No. NASW-3321.

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I. INTRODUCTION

One product of the current exploration of the solar system is the publication of maps of those bodies with solid surfaces (Batson, 1978). These maps show the relative positions of topographic features and are used as bases for correlating a variety of measurements and pictorial data and for regional geologic mapping. In order to produce a map of a planetary surface, it is necessary to first establish a coordinate system for the body and then to determine the latitudes and longitudes of topographic features in this coordinate system. It is the purpose of this paper to define the coordinate systems of each of the Galilean satellites and to present coordinates of features seen in the Voyager pictures of these satellites. The two Voyager encounters with Jupiter are described in Smith et al. (1979a,b). A preliminary report on the progress of the control nets of the Galilean satellites was published by Davies et al. (1979).

The method for computing the control net of these satellites is essentially the same as that used at Mars (Davies, 1972; Davies and Arthur, 1973) and at Mercury (Davies and Batson, 1975) and will not be reviewed here.

Each spacecraft carried two cameras, one with a wide-angle lens and one with a narrow-angle lens. They can be shuttered independently or simultaneously. Pictures were taken of the Pleiades and other star clusters for calibration--using the known coordinates of the stars observed in the pictures, the camera orientation matrices, C, can be determined as well as the focal lengths of the camera lenses. The focal lengths of the Voyager 1 cameras are 200.293 ± 0.177 mm and 1500.19 ± 0.30 mm, and those of the Voyager 2 cameras are 200.770 ± 0.229 mm and 1503.49 ± 0.39 mm (Davies et al., 1979). The matrix relating the orientation of the wide-angle camera to that of the narrow-angle camera can be computed from frames taken simultaneously by each camera. This matrix, $C_{NA}^{-1}C_{WA} = C_{NW}$, is given in Table 1 (Davies et al., 1979).

Table 1

THE MATRIX C_{NW} RELATING THE CAMERA AIMING AND
ROTATION DIRECTIONS OF THE TWO CAMERAS ON EACH SPACECRAFT

	C_{NW}		
<i>Voyager 1</i>	[0.9999950588	-0.0031011413	0.0005151430]
	[0.0031009104	0.9999950916	0.0004483927]
	[-0.0005165310	-0.0004467931	0.9999997668]
<i>Voyager 2</i>	[0.9999966464	-0.0025304697	-0.0005512367]
	[0.0025303754	0.9999967838	-0.0001717796]
	[0.0005516696	0.0001703842	0.9999998333]

II. THE SATELLITE COORDINATE SYSTEMS

The International Astronomical Union has defined coordinate systems for many of the planets and satellites of the solar system (*IAU Transactions*, 1979). The coordinate systems of synchronous satellites, like the Galilean satellites, are based on a resolution adopted in 1973 (*IAU Transactions*, 1974). These IAU-recommended coordinates were the starting point for the Voyager coordinate systems of the satellites.

The *IAU Transactions*, 1979, contain expressions for the direction of the north poles (α_0 , δ_0) and the position of the prime meridians (W) of the four satellites. These expressions are given in standard Earth equatorial coordinates of 1950.0 and, except for the rotation term in the positions of the prime meridians, vary slowly with time. Because the two Voyager spacecraft encounters with Jupiter were separated by only four months, the directions of the north poles were computed at a single time and assumed constant for both encounters (Davies et al., 1979). The angle W is measured along the satellite's equator in an easterly direction with respect to the satellite's north pole from the ascending node of the satellite's equator on the standard Earth equator (1950.0) to the point where the prime meridian crosses the satellite's equator. This led to the following values:

Io	$\alpha_0 = 268^\circ 01$ $\delta_0 = 64^\circ 54$ $W = 262^\circ 7 + 203^\circ 4889538d$
Europa	$\alpha_0 = 269^\circ 07$ $\delta_0 = 64^\circ 34$ $W = 156^\circ 9 + 101^\circ 3747235d$
Ganymede	$\alpha_0 = 268^\circ 45$ $\delta_0 = 64^\circ 62$ $W = 195^\circ 8 + 50^\circ 3176081d$
Callisto	$\alpha_0 = 268^\circ 25$ $\delta_0 = 64^\circ 62$ $W = 158^\circ 0 + 21^\circ 5710715d$

where d = JED-2433282.5.

A point, P, on the surface of a satellite has cartographic coordinates latitude ϕ , west longitude λ , and radius R, and rectangular coordinates X, Y, Z, where

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = R \begin{bmatrix} \cos \phi \cos (360^\circ - \lambda) \\ \cos \phi \sin (360^\circ - \lambda) \\ \sin \phi \end{bmatrix}$$

Because the X, Y, Z coordinate system is right-handed, $(360^\circ - \lambda)$ is used in the expressions for X and Y. The Z axis is the axis of rotation of the satellite with north positive. The X axis lies in the plane of the equator, positive in the direction of 0° longitude. The Y axis lies in the plane of the equator, positive in the direction of 270° west longitude. The standard equatorial coordinates of 1950.0 of the point P_x, P_y, P_z can be expressed as

$$\begin{bmatrix} P_x \\ P_y \\ P_z \end{bmatrix} = MV \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

where

$$M = \begin{bmatrix} \cos(\alpha_0 + 90^\circ) & -\sin(\alpha_0 + 90^\circ) \cos(90^\circ - \delta_0) & \sin(\alpha_0 + 90^\circ) \sin(90^\circ - \delta_0) \\ \sin(\alpha_0 + 90^\circ) & \cos(\alpha_0 + 90^\circ) \cos(90^\circ - \delta_0) & \cos(\alpha_0 + 90^\circ) \sin(90^\circ - \delta_0) \\ 0 & \sin(90^\circ - \delta_0) & \cos(90^\circ - \delta_0) \end{bmatrix}$$

and

$$V = \begin{bmatrix} \cos W & -\sin W & 0 \\ \sin W & \cos W & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

If a picture containing P is taken by the spacecraft at S_x , S_y , S_z , the coordinates X_c , Y_c of P on the picture are given by

$$X_c = \frac{\xi}{\zeta} f, Y_c = \frac{\eta}{\zeta} f$$

where

$$\begin{bmatrix} \xi \\ \eta \\ \zeta \end{bmatrix} = C \begin{bmatrix} P_x \\ P_y \\ P_z \end{bmatrix} - C \begin{bmatrix} S_x \\ S_y \\ S_z \end{bmatrix}$$

and f is the lens focal length and C is the transformation matrix from standard coordinates of 1950.0 into the camera coordinate system. X_c , Y_c , f are expressed in millimeters and R, P_x , P_y , P_z , S_x , S_y , S_z , ξ , η , ζ are in kilometers.

Picture coordinates of the point P are measured manually by counting pixels (picture elements), then the vidicon distortions are removed and the measurements scaled to millimeter coordinates X_o , Y_o at the faceplate of the vidicon. This transformation is controlled by the reseau on the vidicon faceplate. The measurements on the pictures are estimated to the one-tenth pixel and in general are repeatable to a few tenths of a pixel.

Standard photogrammetric methods are used to solve for the unknowns (see, for example, Davies and Arthur, 1973). Approximate values of all parameters are required to initiate the analytical triangulation. The triangulation is a problem in least squares designed to minimize the sum of the squares of the residuals, i.e., $(X_o - X_c)$, $(Y_o - Y_c)$. Observation equations are expressed in terms of those parameters whose values are permitted to vary; the normal equations are formed and solved to give improved values to the desired parameters. In practice, the spacecraft positions S_x , S_y , S_z are never permitted to vary, and the angles of the C matrix are usually variable, as are the latitude ϕ and longitude λ of the control points. The radius at the control points can be fixed, a

single mean radius determined for all points, or the radius at each point determined independently.

The control nets of the satellites are computed by means of single-block analytical triangulations. The normal equations are solved by the conjugate gradient iterative method, which is convenient and converges rapidly as the initial estimates of the parameters are very good. A summary of the control net computations is given in Table 2. The mean radii in the table are computed by entering the radius of the satellite as an unknown in each of the analytical triangulations.

Table 2
SUMMARY OF CONTROL NET COMPUTATIONS OF THE GALILEAN SATELLITES

Parameter	Io	Europa	Ganymede	Callisto
Points	504	112	1547	439
Pictures	234	115	282	200
Observation equations	8510	2564	14724	6670
Normal equations	1710	569	3940	1478
Overdetermination factors	4.98	4.45	3.74	4.51
Standard error of measurement, mm	0.01827	0.01488	0.02258	0.01975
Mean radius, km	1815 \pm 5	1569 \pm 10	2631 \pm 10	2400 \pm 10

The spacecraft trajectories used in the analytical triangulations result from a study by the JPL Voyager Orbit Determination Group, headed by James K. Campbell. This study included Voyager television pictures taken and reduced by the Optical Navigation Group to update simultaneously the two Voyager trajectories and the ephemerides of the four Galilean satellites. The spacecraft positions relative to the centers of mass of the satellites (S_x , S_y , S_z) are required for the analytical triangulations.

During the picture-taking sequences it was possible occasionally to take simultaneous wide-angle and narrow-angle pictures with two satellites in the wide-angle frame and one with useful surface detail

in the narrow-angle frame. Knowing the locations of the satellites, the wide-angle camera orientation matrix C_{WA} could be determined, and since the matrix C_{NW} was known from the star calibrations, the narrow-angle camera orientation matrix could be calculated: $C_{NA} = C_{NW}C_{WA}$. Thus, in the control net computations, the camera orientation matrices of a few frames are constrained by weights. Those frames with C matrices computed from simultaneous exposures are given in Table 3.

Table 3

NARROW-ANGLE FRAMES WITH ORIENTATION MATRICES
CONSTRAINED BY SIMULTANEOUSLY EXPOSED WIDE-ANGLE FRAMES

Satellite	FDS Frame	Picture Number	2-Pixel Surface Resolution (km)
Io	16322.14	1369J1-003	53.0
	16322.18	1373J1-003	53.0
	16322.22	1377J1-003	53.0
Europa	16323.14	1429J1-003	45.3
	16323.18	1433J1-003	45.2
	16357.07	1663J1-002	39.1
	16357.11	1667J1-002	39.1
Ganymede	16289.32	1207J1-004	66.0
	16289.36	1211J1-004	65.9
	16289.40	1215J1-004	65.9
	16356.55	1651J1-002	47.5
Callisto	16321.59	1354J1-03	91.9
	16322.03	1358J1-003	91.8
	16323.00	1415J1-003	91.2
	16323.04	1419J1-003	91.2
	16323.08	1423J1-003	91.1

Peale (1977) showed that, within a few degrees, the rotation axes of the Galilean satellites are normal to their orbital planes at all times. With this information, the directions of the north poles of the Galilean satellites were derived by Lieske (1979) and adopted by the IAU (*Transactions*, 1979). Using control net data, analytical triangulations were carried out in which the direction of the spin

axis was treated as an unknown. The results of these computations, given in Table 4, confirm Peale's analysis and suggest that these results do not offer improvements over the IAU recommendations.

Table 4

THE DIRECTIONS OF THE NORTH POLES OF THE
GALILEAN SATELLITES AS MEASURED BY CONTROL NET COMPUTATIONS

Satellite	IAU North Pole Direction		Measured North Pole Direction with Estimated Error	
	α_0	δ_0	α_0	δ_0
Io	268°01	64°54	267°91 \pm 0°01	64°56 \pm 0°01
Europa	269°07	64°34	268°91 \pm 0°26	64°27 \pm 0°06
Ganymede	268°45	64°62	268°56 \pm 0°32	64°64 \pm 0°07
Callisto	268°25	64°62	268°10 \pm 0°21	64°38 \pm 0°09

The system longitudes on Mars (Davies and Arthur, 1973) and Mercury (Davies and Batson, 1975) have been defined by surface features. The intent is to do the same for the Galilean satellites. However, at Io it is not obvious how to select a small, permanent feature which can be identified on future missions because of the high rate of resurfacing due to volcanism (Johnson et al., 1979; Morrison et al., 1979). For this reason, no change is suggested for the definition of longitudes on Io from that of the IAU (*Transactions*, 1979). Small craters near the equators have been selected to define the longitude systems on Europa, Ganymede, and Callisto.

On Europa, the crater Cilix (point 52) defines 182° longitude

On Ganymede, the crater Anat (point 1000) defines 128° longitude

On Callisto, the crater Saga (point 400) defines 326° longitude

These longitudes differ from the IAU longitudes by less than 0°7, according to the current control net computations. The points can be seen on Figs. 1 to 3.



Fig. 1—Cilix defines the 182° meridian on Europa
(Frame FDS 20649.13 Mercator Projection)

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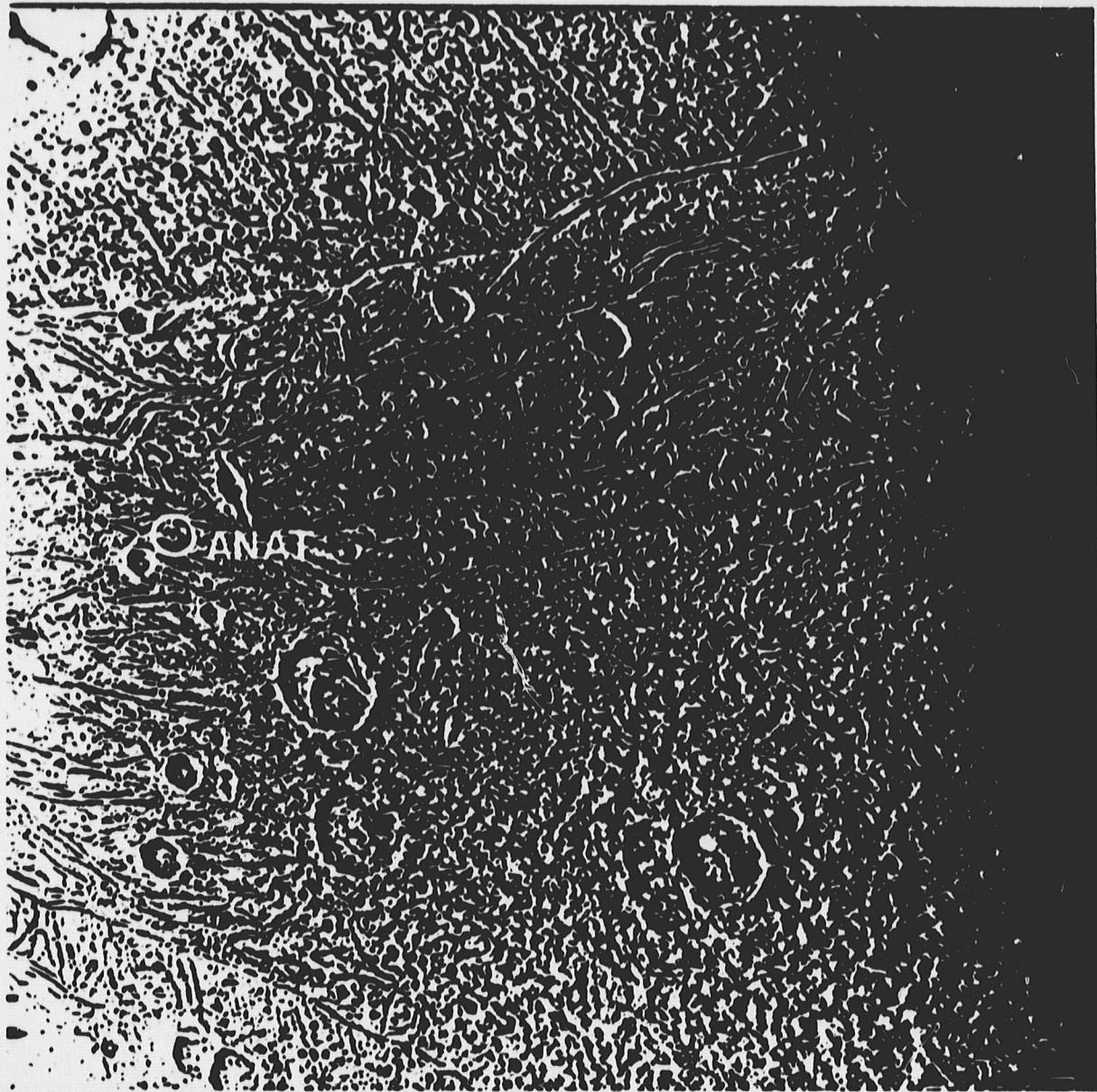


Fig. 2—Anat defines the 128° meridian on Ganymede
(Frame FDS 20638.39)

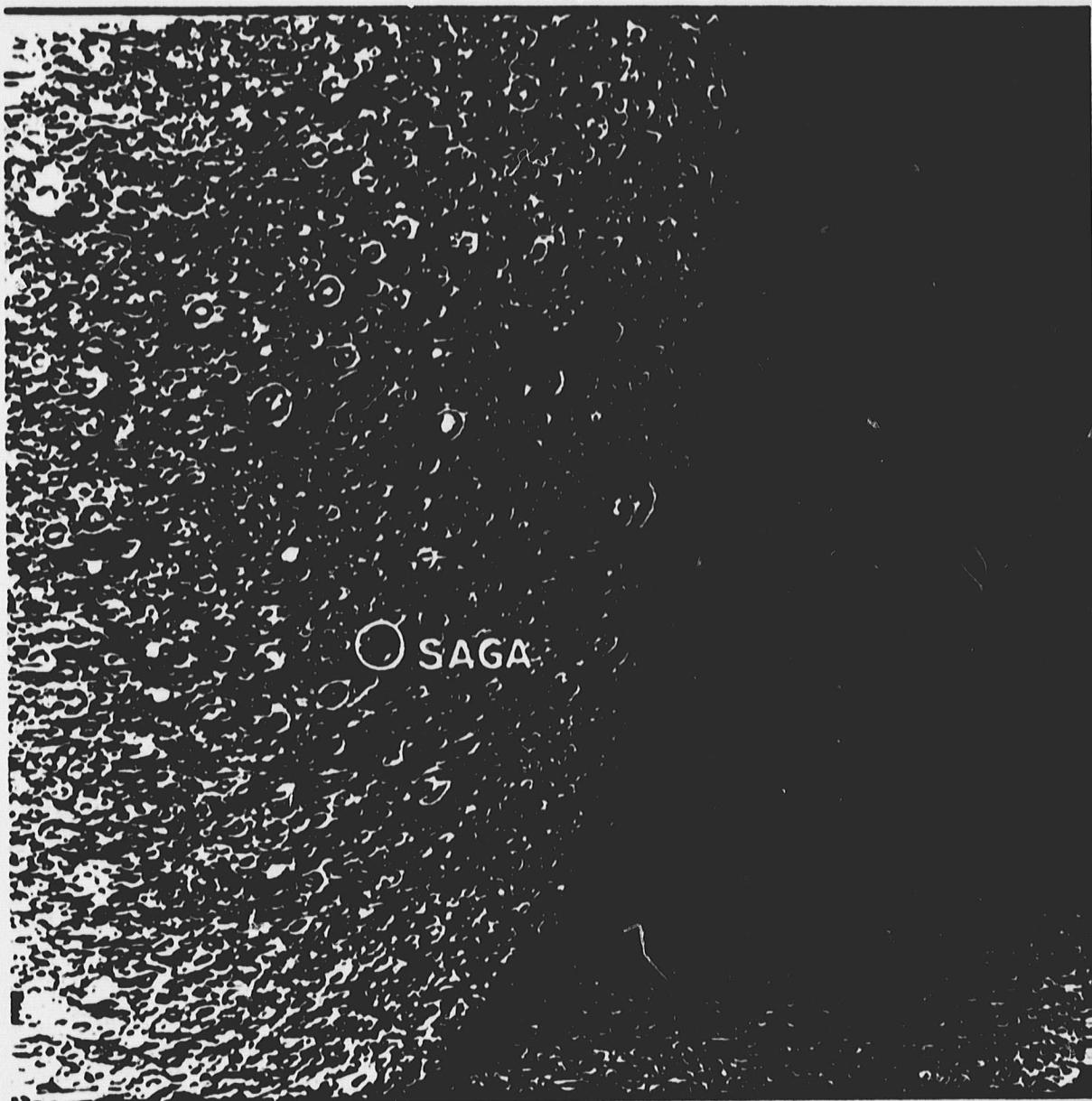


Fig. 3—Saga defines the 326° meridian on Callisto
(Frame FDS 16421.27)

The Voyager coordinate system now in use for the Galilean satellites has the following values for the direction of the spin axis and prime meridian in standard Earth equator (1950.0) coordinates:

Io $\alpha_0 = 268^\circ 01$
 $\delta_0 = 64^\circ 54$
 W = $262^\circ 7 + 203^\circ 4889538d$

Europa $\alpha_0 = 269^\circ 07$
 $\delta_0 = 64^\circ 34$
 W = $157^\circ 3921 + 101^\circ 3747235d$

Ganymede $\alpha_0 = 268^\circ 45$
 $\delta_0 = 64^\circ 62$
 W = $196^\circ 4873 + 50^\circ 3176081d$

Callisto $\alpha_0 = 268^\circ 25$
 $\delta_0 = 64^\circ 62$
 W = $157^\circ 8931 + 21^\circ 5710715d$

where d = JED-2433282.5.

III. COORDINATES OF THE CONTROL POINTS

The control points are selected and identified on individual frames and their position measured by counting pixels on the pictures. These measurements are corrected for geometric distortions using the reseau and scaled to millimeter coordinates in the camera focal plane. They may then be incorporated into the analytical triangulation.

Control points that are easily seen are identified on U.S. Geological Survey 1:25,000,000 scale maps of the satellites, as shown in Figs. 4 through 7. Most of the points are too small to be seen on these maps, and there are too many to identify here. A few of the points correspond to features that have been given names by the IAU Working Group on Solar System Nomenclature (*Transactions*, 1979). To aid in their identification, they have been listed in Tables 5 through 8. The coordinates of the control points are given in Tables 9 through 12.

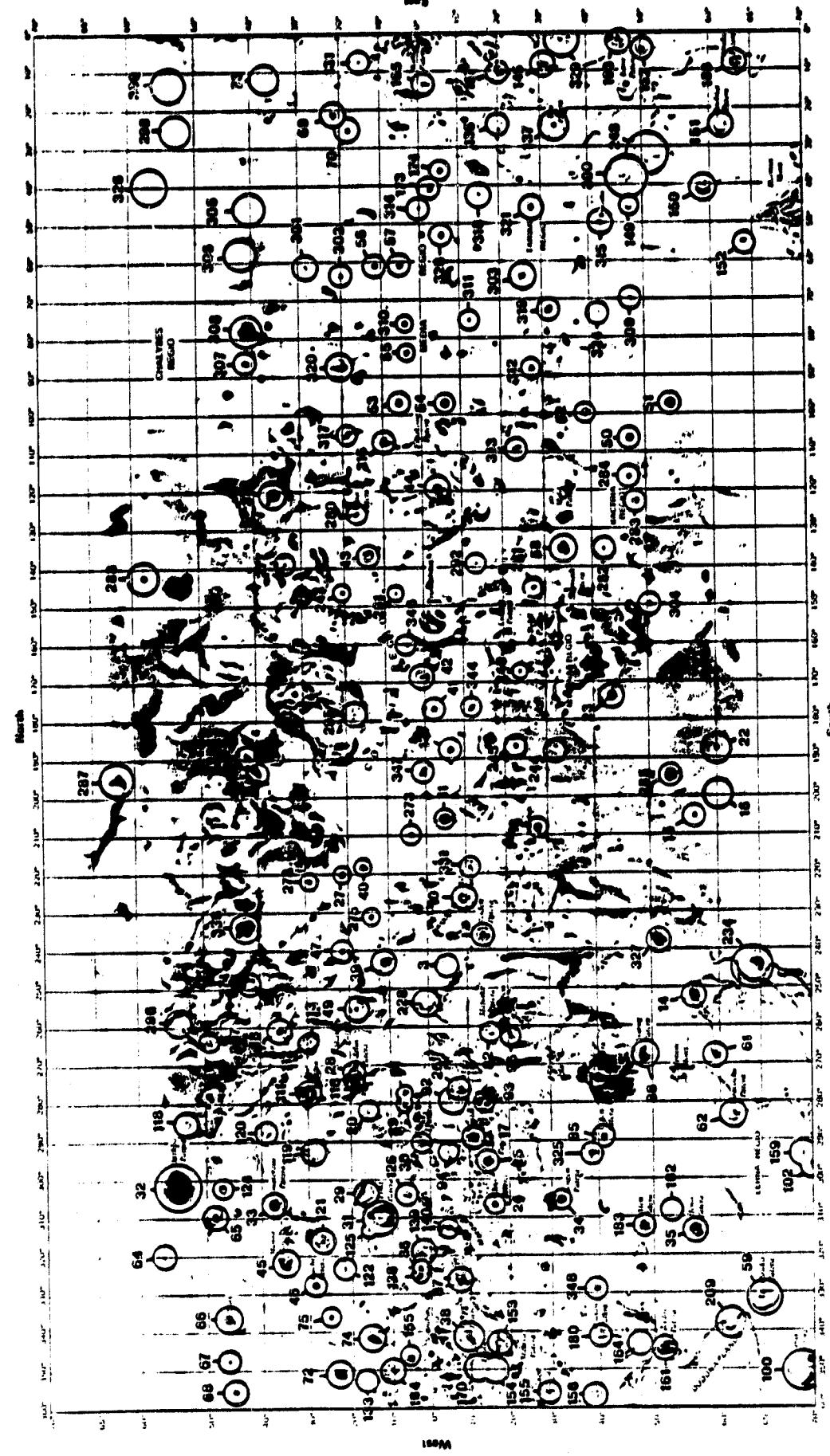


FIG. 4.—Selected control points identified on U.S. Geological Survey map of Io.

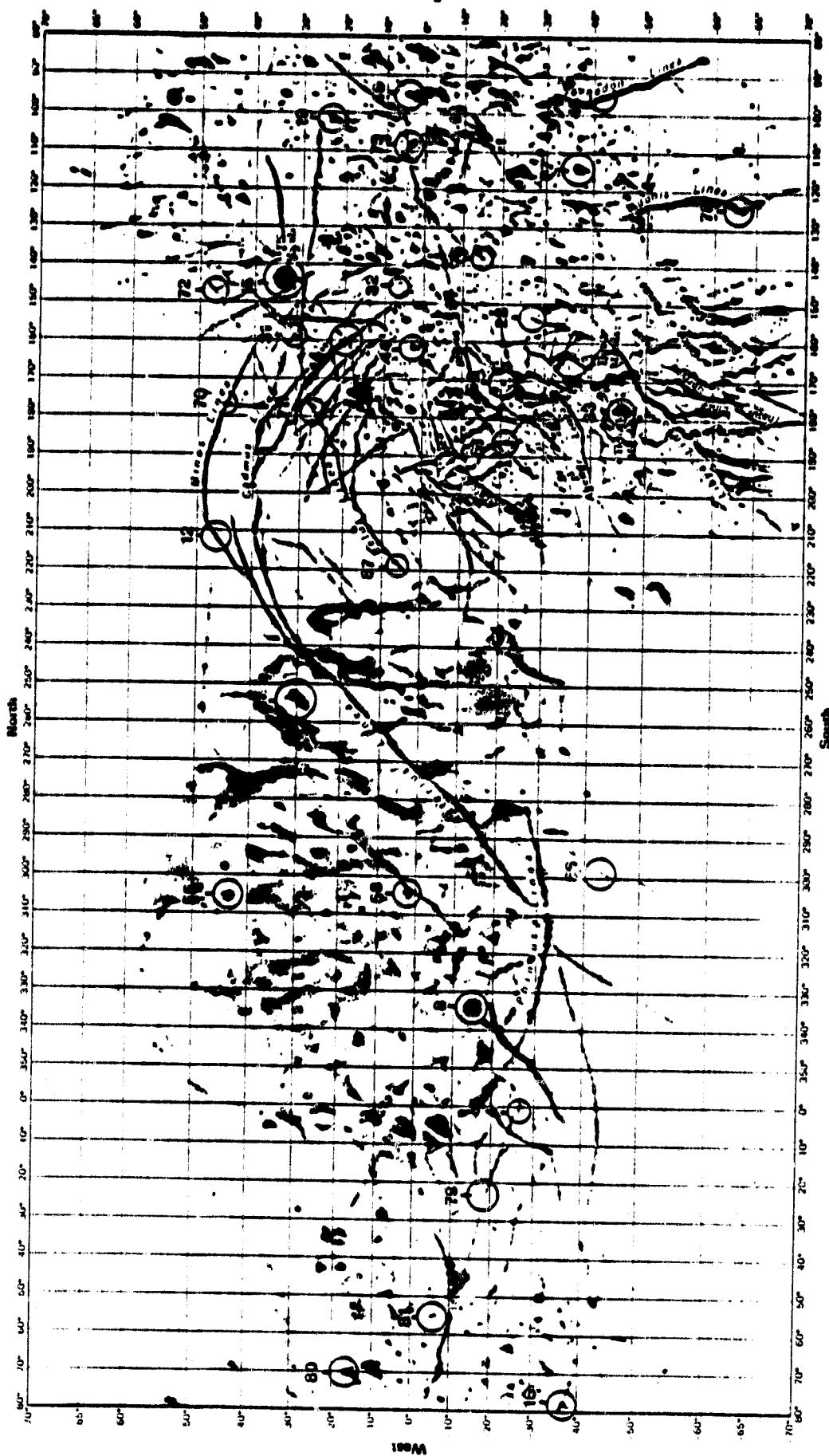


Fig. 5.—Selected control points identified on U.S. Geological Survey map of Europe

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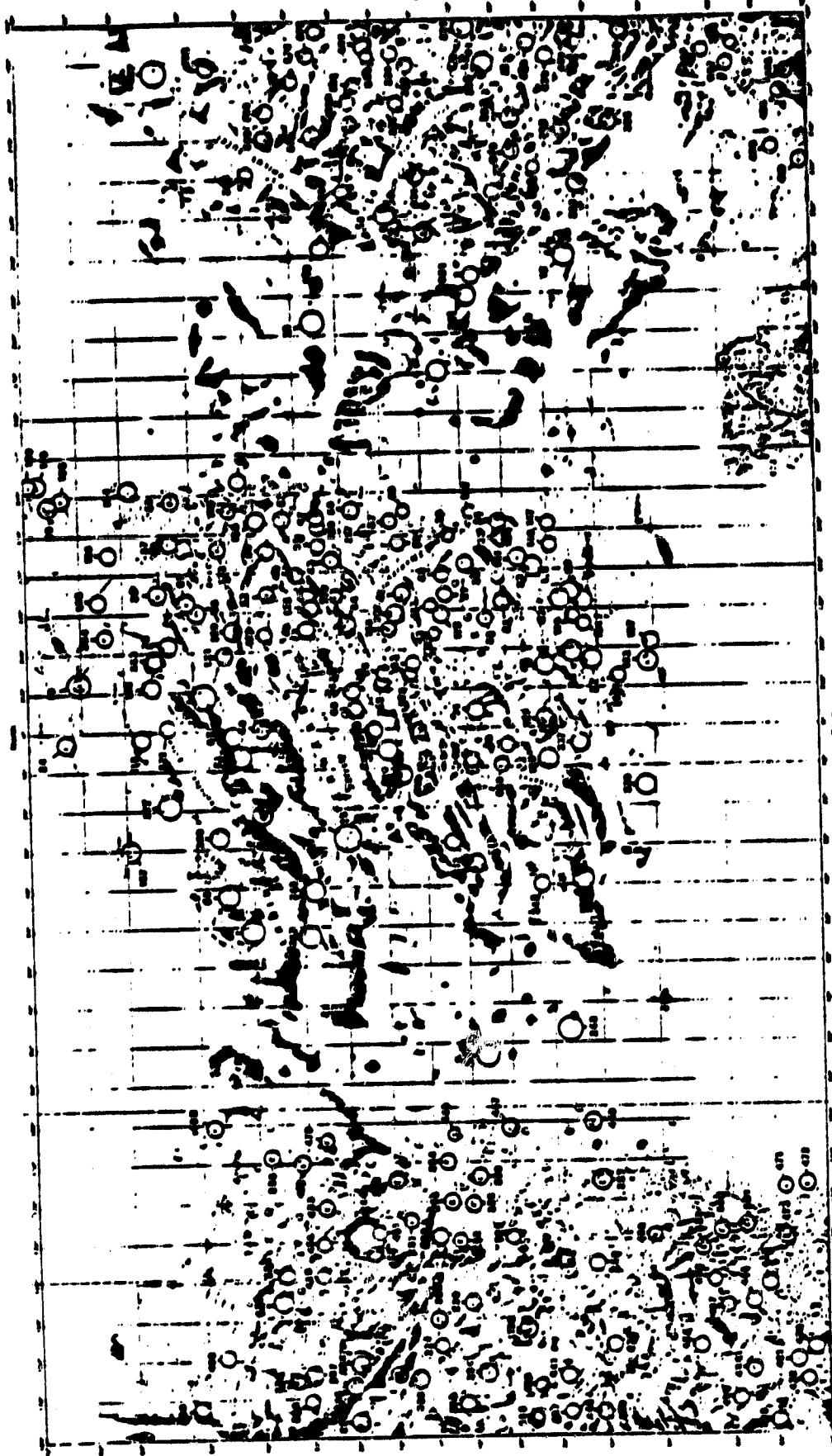


Fig. 6--Selected control points identified on U.S. Geological Survey map of Ganymede

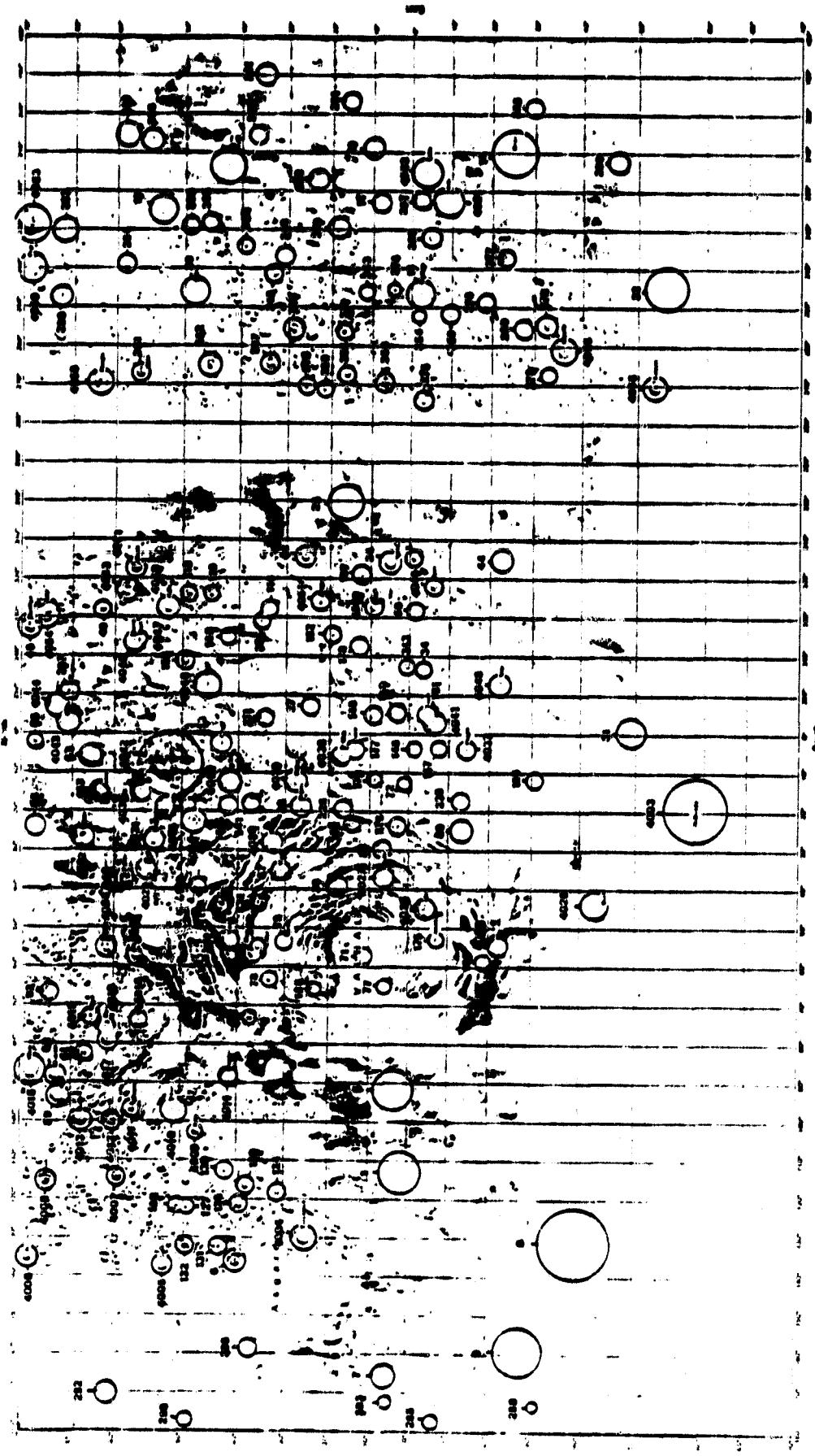


Fig. 7—Selected control points identified on U.S. Geological Survey map of Callisto

Table 5
IO: CONTROL POINTS IDENTIFIED BY NAMES

Name	Control Point Number	Name	Control Point Number	Name	Control Point Number
<i>Catena</i>		<i>Patera</i>		<i>Patera</i>	
Mazda	1015	Creidne	161	Malik	1011
		Culann	1007	Manus	45
<i>Mons</i>		Daedalus	116	Maui	280
Haemus	1012	Dazhbog	32	Mihr	24
Silplum	1020	Emaking	44	Nina	1010
		Fuchi	46	Nusku	188
<i>Tholus</i>		Galai	17	Nyambe	143
Apis	170	Gibil	25	Ra	37
Inachus	154	Heno	35	Reiden	9
		Hephaestus	30	Ruwa	1002
<i>Patera</i>		Hiruko	59	Sengen	34
Amaterasu	33	Horus	38	Shakuru	1000
Asha	10	Inti	100	Shamash	1009
Atar	111	Kane	1001	Tohil	1008
Aten	183	Loki	31	Svarog	86
Babbar	1	Maasaw	180	Ulgen	85
Bochis	151	Mafuike	1014	Uta	137

Table 6
EUROPA:
CONTROL POINTS IDENTIFIED BY NAMES

Name	Control Point Number
<i>Mascula</i>	
Thera	33
Tyre	15
<i>Crater</i>	
Cilix	52

Table 7
GANYMEDAE:
CONTROL POINTS IDENTIFIED BY NAMES

Name	Control Point Number	Name	Control Point Number
<i>Craters</i>			
Achelous	24	Keret	3031
Adad	3003	Khumbam	23
Adapa	3016	Kishar	3017
Ammura	3025	Malkart	221
Anat	1000	Mor	3006
Anu	3002	Nabu	3014
Asshur	36	Namtar	152
Aya	99	Nut	3019
Baal	3007	Osiris	3023
Danel	319	Ruti	3013
Diment	3010	Sapas	157
Enlil	38	Sebek	19
Eshmun	3022	Sin	116
Etana	98	Tanit	3005
Gilgamesh	3024	Tesmus	3012
Gula	3001	Tros	3009
Hathor	3018	Zagar	3004
Isis	3020		

Table 8
CALLISTO: CONTROL POINTS IDENTIFIED BY NAMES

Name	Control Point Number	Name	Control Point Number	Name	Control Point Number
<i>Large-Ringed Features</i>					
<i>Craters</i>					
Adlinda	4003	Fili	207	Mimir	79
Valhalla	71	Finnr	177	Mitsina	4011
Adal	208	Freki	4069	Modi	4008
Agroi	4040	Frodi	4006	Nama	4048
Akycha	4070	Fulla	4065	Nar	4025
Alfr	4061	Fulnir	140	Nerivik	4020
Ali	4023	Geri	4044	Nidi	59
Anarr	213	Gisl	4029	Nori	4046
Aningan	4042	Gloi	20	Nuada	4058
Askr	4052	Goll	4053	Oski	261
Balkr	4039	Gondul	4007	Ottar	4012
Bavorr	4034	Grimr	12	Pekko	4038
Beli	4017	Gunnr	4013	Saga	400
Bragi	4066	Gymir	4024	Sarakka	175
Brami	35	Habrok	4064	Seginek	4031
Bran	10	Haki	41	Sholmo	4035
Buga	4051	Har	4041	Sigyn	4030
Buri	4026	Hepti	4032	Skoll	4071
Burr	6	Hodr	4015	Sudri	4005
Danr	4018	Hoenir	4056	Sumbur	46
Dia	4067	Hogni	4037	Tindr	181
Dryops	4068	Igaluk	24	Tornarsuk	4004
Durim	60	Jumo	167	Tyn	4063
Egdir	37	Kari	4009	Valfodr	11
Erlik	4043	Karl	4047	Vali	4050
Fadir	4036	Loni	4062	Vestri	4022
		Losy	4054	Vitr	4045
		Mera	4019	Ymir	4010

TABLE 9. IO: Coordinates of Control Points

(degrees)

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
1	-39.6	272.2	42	1.3	167.4	82	-15.3	261.1
2	-16.8	254.5	43	14.8	136.4	83	-16.3	272.0
3	-4.5	244.1	44	-3.2	119.4	85	-40.6	287.8
4	17.8	265.2	45	35.3	322.1	86	-48.3	266.8
5	17.7	271.3	46	28.3	328.0	88	-58.8	267.0
6	7.6	242.0	47	22.4	239.7	89	6.2	279.9
7	15.9	240.0	48	36.8	260.7	90	3.5	283.7
8	12.1	232.7	49	18.6	254.6	91	6.4	277.1
9	-13.4	235.8	50	-47.1	107.4	92	-5.5	279.0
10	-8.8	225.8	51	-53.3	99.6	93	-12.7	278.8
11	-3.7	205.2	52	-38.6	100.1	94	-4.9	292.7
12	-5.5	187.1	53	6.3	97.0	95	-20.2	277.3
13	-27.0	207.6	54	-5.5	97.6	96	-20.1	261.8
14	-55.6	251.5	55	3.5	83.9	97	-23.2	260.6
15	-55.7	204.7	56	11.4	61.5	99	-10.6	270.9
16	-59.4	189.2	57	5.1	61.4	99	-43.4	239.7
17	-10.8	288.4	58	-33.9	135.2	100	-68.1	349.3
18	37.9	307.6	59	-65.0	330.3	101	-72.3	321.6
19	15.7	281.9	60	-73.6	338.7	102	-70.6	296.1
20	39.7	287.2	61	-54.0	269.6	103	-66.4	342.6
21								
22	-58.9	177.7	62	-62.1	281.2	104	-79.2	13.0
23	-42.2	173.7	63	-76.6	281.6	105	-79.7	14.2
24	-16.3	305.8	64	57.2	321.0	111	30.4	279.0
25	-14.8	295.0	65	48.8	310.3	112	30.2	264.5
26	-7.2	275.7	66	45.1	337.6	113	29.8	264.1
27	22.1	219.8	67	44.2	348.9	114	15.4	281.5
28	19.1	271.9	68	43.3	357.4	115	15.9	281.5
29	16.6	303.7	69	19.3	23.6	116	19.0	274.7
30	1.9	290.2	70	15.9	26.6	118	53.7	285.6
31	13.2	309.6	71	25.1	10.2	119	28.6	292.5
32	54.6	301.6	72	22.4	351.3	120	39.7	287.3
33	37.6	306.9	73	35.7	14.6	121	26.9	316.5
34	-32.6	304.3	74	14.1	341.2	122	21.6	323.4
35	-56.9	312.2	75	24.6	336.1	123	51.9	357.4
36	1.8	322.1	76	-39.0	254.6	124	47.4	302.7
37	-8.4	325.3	77	-30.6	271.7	125	15.7	313.3
38	-9.8	339.5	78	-26.4	267.9	126	5.9	303.7
39	11.8	242.6	79	-27.8	283.8	127	11.1	322.1
40	16.9	218.0	80	-31.4	268.3	128	-3.0	304.1
41	-1.6	176.9	81	-24.4	260.4	129	26.4	35.3

IO

TABLE 9--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
130	51.8	2.5	170	-11.1	348.9	212	-64.3	355.3
131	9.2	5.7	172	-11.6	9.0	213	-65.0	359.4
132	3.5	17.3	173	-6.6	34.1	214	-80.3	347.3
133	16.3	352.7	174	-4.8	38.5	215	-82.0	30.7
134	10.2	349.2	175	-13.0	22.9	216	-80.5	35.8
135	5.7	344.6	176	-14.8	328.9	217	-78.3	2.7
136	-21.8	25.1	177	-19.5	324.4	218	-73.5	354.2
137	-35.3	25.1	179	-20.1	325.2	219	-75.1	359.5
138	1.8	323.6	179	-40.4	334.3	220	-70.8	44.1
139	1.6	317.8	180	-40.0	340.5	221	-70.4	47.5
140	-5.5	312.1	181	-35.6	332.6	222	-73.1	31.7
141	-9.5	317.1	192	-53.2	307.3	223	-64.5	345.0
142	7.9	334.5	183	-48.2	311.0	224	-55.0	349.7
143	-3.9	342.1	184	-73.6	264.9	225	-62.8	332.2
144	0.3	329.6	185	-75.1	246.9	226	-64.3	332.8
145	-31.5	7.1	186	-69.5	279.3	227	-71.8	327.5
146	-6.7	251.0	187	-62.0	351.9	228	0.5	255.3
147	-47.0	12.5	188	-62.9	6.5	229	0.2	267.5
148	-47.3	39.7	189	-56.7	357.0	230	-4.2	269.0
149	-49.7	44.6	190	-61.7	12.5	232	-4.7	262.9
150	-58.6	35.5	191	-66.2	3.8	233	-67.0	247.5
151	-61.1	21.5	193	-93.1	47.9	234	-62.7	244.8
152	-64.5	49.4	194	-71.8	53.0	235	-66.9	249.0
153	-16.6	342.2	195	-55.7	346.7	236	-1.9	264.1
154	-15.9	349.1	196	-35.2	238.1	237	-18.2	305.1
155	-28.8	353.7	197	-70.2	28.9	238	-21.6	297.6
156	-38.2	354.9	198	-21.1	15.7	239	-22.6	298.5
157	-74.5	313.8	199	-16.8	53.8	240	-42.2	339.8
158	-79.1	319.9	200	-20.3	6.9	241	-43.7	340.4
159	-69.9	292.3	201	-36.5	9.9	242	-34.1	8.3
160	-2.3	297.7	202	-41.2	37.7	243	-35.4	10.6
161	-51.3	343.6	203	-9.4	332.0	244	-31.3	187.5
162	-49.7	2.5	204	-8.7	335.1	245	-20.8	186.3
163	-45.4	0.2	205	-70.5	302.2	246	-22.8	166.3
164	-46.8	340.5	206	-72.5	313.4	247	22.1	145.7
165	-2.8	14.0	207	-79.0	342.0	248	-52.3	30.3
166	-18.7	2.6	208	-76.4	329.0	249	-9.4	321.7
167	-20.9	10.9	209	-60.9	337.4	250	-5.9	320.5
168	-0.3	309.9	210	-64.6	341.6	251	-17.9	333.2
169	-11.7	305.6	211	-63.2	348.6	252	8.1	326.9

IO

TABLE 9—Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
253	-12.7	330.9	293	16.9	193.0	335	-12.4	276.4
254	-33.3	10.1	294	67.5	249.5	336	-13.0	292.0
255	-28.7	63.6	295	19.6	176.6	337	-14.7	284.3
256	13.8	331.2	296	54.7	260.0	338	-13.9	287.9
257	0.8	345.7	297	49.5	264.9	339	-13.0	285.7
258	1.0	347.5	298	54.5	24.9	340	-11.6	281.6
259	-71.7	34.8	299	52.7	13.4	341	-9.2	283.1
260	-70.8	35.9	300	-48.2	36.6	342	-8.3	274.8
261	-70.4	36.1	301	27.5	58.9	343	-10.7	274.5
262	-68.4	19.9	302	19.5	62.7	344	-11.3	176.2
263	-64.1	31.4	303	-25.5	64.3	345	-20.6	186.2
264	-69.1	44.2	304	-49.9	151.3	346	2.8	157.3
265	-65.7	46.1	305	40.1	46.4	347	1.4	193.0
266	-64.9	47.8	306	41.6	57.0	348	-40.5	326.5
267	-64.2	49.3	307	38.5	87.4	349	16.8	300.6
268	-63.0	47.5	308	40.6	75.7	350	-7.1	25.1
269	-73.8	35.8	309	-47.3	70.9	351	-10.8	24.3
270	-67.2	42.9	310	4.2	75.7	352	-13.6	28.4
271	-66.1	23.6	311	-12.7	75.5	353	-11.3	36.9
272	30.2	221.6	312	-27.2	88.1	354	-9.4	36.8
273	4.6	209.0	314	-4.2	39.2	355	-3.7	47.0
274	43.2	249.0	315	-44.1	53.4	356	-5.4	13.6
275	15.0	231.4	316	10.8	110.1	357	-2.9	18.8
276	11.9	206.2	317	19.7	108.4	358	-3.7	20.8
277	35.4	137.4	318	-17.0	42.4	359	-4.9	16.5
278	37.1	118.6	319	-30.8	73.4	360	-8.5	9.6
279	22.0	145.6	320	22.2	89.5	361	-9.3	13.6
280	16.4	123.8	321	-29.8	45.3	362	-11.6	13.0
281	-25.6	145.1	322	-45.2	52.7	363	-12.4	11.4
282	-41.3	137.4	323	-5.8	83.9	364	-14.2	2.7
283	-49.3	124.0	324	-41.7	79.5	365	-52.4	13.2
284	-46.0	118.1	325	-38.3	291.3	366	-53.8	26.6
285	-52.2	193.2	326	58.7	40.4	367	-41.1	359.8
286	43.0	191.0	327	-49.5	235.9	368	-31.5	6.3
287	64.4	190.1	328	-7.2	54.5	369	-37.1	32.1
288	60.7	143.1	329	-43.7	353.0	370	-36.4	34.5
289	59.1	118.1	330	-8.2	24.0	371	-20.0	13.6
290	40.5	192.3	331	-10.1	217.6	372	-21.8	7.2
291	7.9	145.9	333	43.6	232.7	373	-17.7	5.2
292	-12.4	138.8	334	-16.1	272.0	374	-18.7	359.9

IO

TABLE 9--continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
375	-16.6	341.5	415	-22.1	245.4	455	-6.9	321.5
376	-15.6	348.9	416	-24.0	244.9	456	34.5	317.1
377	-8.7	338.5	417	-32.3	260.0	457	36.5	321.1
378	-3.2	355.9	418	-29.2	256.2	458	26.4	312.5
379	1.9	347.9	419	-34.2	253.3	459	-9.3	303.2
380	-4.7	326.8	420	-37.9	270.0	460	-4.9	308.9
381	3.6	332.7	421	-36.9	274.9	461	-12.4	302.3
382	18.0	316.5	422	-36.6	245.1	462	9.4	287.4
383	13.9	317.5	423	-43.6	259.9	463	2.8	290.0
384	10.5	313.2	424	-39.9	283.1	464	1.0	283.6
385	0.2	306.5	425	-48.7	266.2	465	22.5	279.0
386	32.6	303.2	426	-53.2	241.8	466	43.6	269.8
387	34.6	290.9	427	-55.2	275.5	467	-1.0	320.7
388	31.7	292.0	428	-58.7	261.8	468	2.1	298.1
389	44.9	307.9	429	-62.7	247.7	469	21.0	324.5
390	14.1	299.0	430	-66.7	254.0	470	38.3	2.9
391	18.5	306.0	431	-77.8	257.4	471	30.4	40.1
392	25.1	272.3	432	-71.4	297.4	472	49.1	280.5
393	4.9	278.9	433	-76.2	285.1	473	62.8	314.8
394	8.3	276.6	434	-61.4	301.9	474	43.3	290.1
395	-5.6	293.1	435	-80.9	335.3	475	23.8	288.4
396	-2.9	295.2	436	-60.2	338.4	476	26.8	272.2
397	-2.9	264.9	437	-64.3	355.2	477	33.6	277.7
398	-1.2	265.1	438	-70.9	21.3	478	15.4	251.6
399	-12.5	275.8	439	-7.4	330.8	479	26.6	264.3
400	-7.0	274.5	440	-8.0	334.6	480	12.7	270.2
401	-14.6	287.1	441	-17.7	333.2	481	-33.2	299.4
402	-12.2	287.0	442	-20.2	340.9	482	-23.2	296.1
403	-16.9	290.9	443	-23.4	337.2	483	-23.8	294.7
404	-14.1	291.7	444	-33.4	335.2	484	-28.6	303.5
405	-6.6	248.0	445	-31.9	339.3	485	-23.4	301.1
406	-14.9	261.2	446	-29.6	331.7	486	-25.3	299.4
407	-8.7	243.6	447	-69.2	39.8	487	-26.8	298.0
408	-20.8	268.4	448	-88.9	16.9	488	23.5	266.2
409	-19.4	270.0	449	10.3	356.1	489	-48.1	13.5
410	-22.9	281.3	450	15.2	4.0	490	0.5	3.8
411	-26.4	282.9	451	2.5	6.4	491	-18.3	255.4
412	-27.9	285.7	452	9.7	356.3	492	-1.8	152.5
413	-37.0	294.3	453	7.1	0.5	493	25.1	114.5
414	-33.4	296.0	454	12.1	334.8	494	19.4	121.9

IO

TABLE 9—Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
1007	-19.7	159.6	1015	-8.5	313.1	1023	-34.0	62.8
1008	-25.2	158.2	1016	-57.8	351.2	5131	8.9	4.4
1009	-34.4	152.0	1017	-31.9	163.1	5132	3.1	16.3
1010	-38.2	166.0	1018	-80.2	264.5	5148	-47.6	37.7
1011	-34.2	128.5	1019	-43.7	124.0	5151	-61.1	20.5
1012	-69.5	49.9	1020	-52.1	273.7	5152	-64.8	46.3
1013	-61.8	293.7	1021	58.8	97.1	5173	-2.9	43.6
1014	-13.3	259.7	1022	9.5	182.0	5174	-3.2	47.7

TABLE 10. EUROPA: Coordinates of Control Points
(degrees)

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
3	41.7	356.3	43	-50.9	172.6	80	25.1	71.3
4	-26.2	354.1	44	0.9	164.2	81	3.3	60.2
5	10.6	339.1	45	-33.0	93.7	82	-64.3	147.7
8	-16.1	333.2	46	8.0	95.7	83	32.2	327.2
9	23.9	12.0	47	24.9	176.5	84	-37.9	213.0
10	-9.6	234.1	48	-3.1	195.7	85	-34.8	266.0
11	16.9	199.5	49	5.5	198.0	86	46.3	266.7
12	45.7	216.9	50	-32.7	191.0	87	13.2	225.4
13	-4.6	264.1	51	9.3	169.0	88	-11.3	133.8
14	18.1	163.6	52	1.3	182.0	89	-20.5	134.1
15	32.0	147.0	53	-28.7	165.2	2001	-28.9	314.4
16	-29.4	76.0	54	22.3	304.1	2002	29.1	251.3
17	9.0	26.8	55	39.1	314.7	2003	-26.4	339.8
18	42.6	23.3	56	-39.5	299.4	2004	13.6	225.8
19	29.0	103.3	57	27.0	266.2	2006	45.3	219.9
20	-55.6	159.6	58	2.8	309.1	2007	31.1	149.5
21	-47.3	159.4	59	-18.8	165.9	2008	-19.6	203.7
22	-48.1	175.9	60	-23.6	174.4	2009	-1.5	171.1
23	-69.5	208.2	61	-23.4	187.9	2010	-25.7	194.9
24	-13.6	155.0	62	-21.9	199.2	2011	8.5	110.4
25	-20.3	156.5	63	-31.3	177.8	2012	-44.0	220.9
26	-10.5	174.3	64	-14.1	206.2	2013	-35.0	175.2
27	-9.0	188.5	65	-45.4	207.9	2014	-61.0	272.9
28	-29.6	154.1	66	-38.8	211.0	2015	-40.7	153.1
29	3.9	157.0	67	-19.6	213.7	2016	-37.6	122.5
30	16.6	158.5	68	-59.3	203.5	2017	-59.7	113.1
31	28.6	162.1	69	20.0	195.6	2018	-22.9	94.4
32	3.9	147.9	70	41.7	174.7	2019	-51.3	80.4
33	-47.7	181.1	71	28.4	186.5	2020	-57.7	176.4
34	-12.5	197.9	72	46.6	149.5	2021	-76.3	216.6
35	-5.5	203.8	73	-23.5	137.4	2022	-61.8	182.3
36	-42.2	170.6	74	-42.1	140.7	2023	-49.5	146.4
37	-36.9	165.2	75	8.7	110.6	2025	-58.2	153.4
38	-37.4	177.8	76	-10.7	134.2	2026	-70.0	215.2
39	-4.7	170.9	77	-31.4	109.3	2028	-45.3	171.6
40	-5.9	152.3	78	-59.8	113.8	5043	-50.6	163.3
41	-39.8	197.3	79	-17.5	29.4	5079	-19.9	22.9
42	26.5	171.6						

TABLE 11. GANYMEDE: Coordinates of Control Points

(degrees)

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
8	-8.0	278.3	49	21.3	340.5	90	-13.0	33.0
9	13.2	272.0	50	33.1	320.7	91	22.7	63.8
10	32.1	261.0	51	20.0	319.0	93	-47.2	334.4
11	77.1	277.3	52	30.5	331.5	94	-51.0	336.2
12	-24.0	241.0	53	29.2	314.5	95	49.0	337.6
13	6.4	291.8	54	11.3	338.1	96	47.8	337.3
14	13.0	232.9	55	6.1	319.6	97	49.6	335.3
15	49.1	340.2	56	12.0	310.7	98	72.8	342.3
16	-1.0	11.0	57	2.1	313.6	99	66.2	325.2
17	15.7	332.8	58	-1.5	319.2	100	65.0	322.9
18	-40.9	349.7	59	-1.5	312.2	101	78.0	8.2
19	60.3	358.4	61	38.4	14.2	102	76.9	3.4
20	42.7	359.3	62	39.0	8.0	103	80.3	330.0
21	-14.2	331.5	63	31.3	8.3	104	84.6	12.8
22	-12.9	326.6	64	28.6	17.0	105	84.9	344.4
23	-38.5	327.4	65	34.7	27.2	106	86.0	343.8
24	61.2	13.6	66	42.5	48.2	107	70.8	15.3
25	-25.4	339.3	67	35.5	52.4	108	60.7	339.9
26	-47.3	348.2	68	15.0	8.5	109	70.7	320.8
27	-53.3	351.5	69	8.3	2.2	110	68.9	319.7
28	67.9	34.0	70	3.0	20.1	112	-15.0	45.2
29	-12.2	321.1	71	-21.8	360.2	113	-23.2	71.6
30	-15.9	318.9	72	-25.1	32.5	115	54.6	10.2
31	-30.2	333.9	73	-22.0	353.5	116	52.1	359.1
32	-18.9	325.7	74	11.9	31.4	117	67.0	14.5
33	-28.0	319.2	75	6.6	349.6	118	68.7	4.6
34	-26.7	315.0	76	1.7	351.9	120	39.7	342.6
35	51.5	346.1	77	-0.1	352.5	121	41.2	347.7
36	53.1	335.2	78	23.4	355.1	122	31.7	342.5
37	53.6	324.3	79	-30.4	10.4	123	45.2	321.4
38	53.2	315.1	80	-33.7	55.0	124	19.9	324.1
39	43.1	307.5	81	-40.2	81.4	125	21.2	334.3
40	41.0	331.8	82	15.4	354.9	126	-40.5	14.4
42	-11.5	341.1	83	-4.0	51.9	127	-39.4	3.6
43	15.9	322.3	84	-11.5	50.7	128	-45.6	42.4
44	14.2	330.9	85	-16.5	69.8	131	-12.4	333.7
45	5.1	330.6	86	13.3	62.1	132	-9.4	70.0
46	-2.0	330.3	87	18.4	56.5	133	-8.5	62.0
47	23.1	313.8	88	5.1	51.3	134	60.3	313.2
48	25.2	326.6	99	-4.9	39.2	135	79.4	324.3

GANYMEDAE

TABLE 11--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
136	60.8	331.1	192	-31.7	341.5	235	-20.1	157.5
137	-9.5	334.7	193	-58.6	356.7	236	-8.2	150.2
141	-34.2	325.4	194	-50.5	343.5	237	-27.4	184.6
144	48.3	326.2	195	-51.7	342.5	238	-40.5	193.5
146	-43.3	320.8	196	-47.9	341.5	239	-40.0	161.1
147	-44.3	314.5	197	-63.0	347.6	240	-36.7	139.2
148	-39.7	310.4	198	-27.3	329.2	241	16.9	107.2
149	-18.9	343.2	199	-29.6	329.5	242	12.1	96.7
152	-62.2	353.8	200	-32.3	356.6	243	7.9	118.7
153	-71.3	16.3	202	-15.9	338.7	244	15.5	132.4
154	-71.2	10.3	203	-20.5	347.2	245	37.6	102.7
155	74.0	50.4	204	1.9	323.9	246	-34.5	92.7
157	57.2	38.0	205	13.4	344.0	247	-15.6	66.7
158	87.4	70.2	206	17.2	340.3	248	22.1	45.9
160	84.9	70.5	207	-0.4	336.8	249	58.1	66.9
161	87.7	341.4	208	8.3	345.0	250	61.1	44.4
163	-5.7	350.6	209	7.3	338.7	251	62.0	41.5
164	-6.0	358.7	210	-1.9	340.5	252	60.0	36.2
165	0.8	340.0	211	20.1	327.0	253	74.2	2.3
166	-18.0	15.0	213	36.5	351.3	254	80.1	34.5
167	-19.3	13.1	214	32.3	347.0	255	76.2	47.1
169	-9.5	12.3	216	69.9	356.4	256	76.7	60.7
169	-8.7	6.6	217	9.0	314.1	257	71.4	63.2
170	-15.9	8.1	218	29.1	242.5	258	79.3	311.9
171	-16.5	2.9	219	36.3	199.6	259	80.1	316.1
173	-0.2	321.1	220	35.0	147.0	260	57.7	30.2
175	-13.5	336.8	221	-10.0	185.7	261	59.0	24.6
177	-21.0	329.9	222	-6.8	176.1	262	61.6	21.6
178	19.9	14.1	223	3.1	161.1	263	52.3	351.3
179	18.2	20.9	224	-1.0	160.2	264	59.4	347.1
180	14.3	15.6	225	-13.1	194.1	265	71.2	359.7
191	9.2	10.6	226	7.9	190.4	266	75.0	341.2
182	13.9	24.7	227	-1.9	192.3	267	55.2	65.2
183	29.7	27.0	228	22.0	176.7	268	56.6	55.6
184	32.6	341.9	229	21.5	169.3	269	56.6	50.6
185	29.2	345.2	230	31.2	171.0	270	46.0	357.0
197	36.5	353.1	231	4.4	219.9	271	51.0	6.6
188	40.0	321.1	232	5.1	236.8	272	53.5	328.1
190	36.4	315.1	233	-0.4	204.7	273	70.6	23.4
191	-39.6	341.1	234	-12.1	167.1	274	23.4	323.3

GANYMEDE

TABLE 11--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
275	22.8	331.5	316	-33.7	76.3	370	-0.0	341.1
276	39.4	325.1	317	0.4	40.4	371	24.4	239.6
277	52.1	28.3	318	-3.8	29.9	372	27.1	222.3
278	53.2	21.8	319	-4.1	25.2	373	22.7	215.4
279	55.0	16.9	320	-3.0	16.4	374	7.7	215.7
280	41.3	32.3	321	0.3	11.3	375	15.2	216.2
281	4.8	127.9	322	2.7	6.7	376	10.3	236.4
282	0.1	152.8	323	1.2	360.2	377	-12.5	206.3
283	-1.1	132.1	324	13.7	22.3	378	-17.1	217.4
294	33.2	140.1	325	-8.0	330.0	379	-11.9	225.5
285	41.1	168.0	326	-26.8	23.5	380	-7.5	234.2
296	33.2	166.0	327	-25.2	9.6	391	-8.7	240.1
287	29.6	165.3	328	-24.2	1.3	382	-4.9	244.1
288	18.5	163.3	329	38.8	43.2	393	-17.3	212.9
289	14.1	190.3	330	34.6	40.9	384	-17.9	208.5
290	20.6	201.0	337	-47.3	10.4	385	-22.1	208.6
291	17.7	196.5	338	-52.7	11.0	386	-27.0	222.9
292	-6.3	134.8	339	-58.6	32.0	387	-28.2	225.8
293	-9.9	128.5	347	23.3	58.2	388	-27.5	212.1
294	-3.7	117.7	348	18.8	47.5	389	-21.4	220.2
295	-4.7	126.3	349	-1.1	44.6	390	-32.9	219.1
296	-18.0	134.7	350	-0.7	34.3	391	-32.7	225.9
297	-37.4	122.8	351	1.9	31.4	393	-25.8	241.8
298	-11.0	119.6	352	14.7	360.4	394	-40.4	228.6
299	22.5	223.3	353	9.5	357.7	395	35.0	113.9
301	-9.7	252.9	354	5.7	356.7	396	-69.4	188.8
302	1.4	244.4	355	1.6	354.8	397	-65.0	190.1
303	-35.1	210.6	356	40.5	19.8	398	-67.1	185.6
304	45.0	218.6	358	21.9	340.1	399	-68.7	174.9
305	4.3	167.1	359	-14.2	334.7	400	-66.6	177.6
306	1.4	184.5	360	26.0	241.3	401	-70.3	190.4
307	8.5	202.0	361	17.9	340.9	402	-73.0	181.4
308	5.4	193.7	362	19.7	340.3	403	-73.9	184.8
309	-6.3	48.5	363	19.1	344.9	404	-75.2	191.2
310	-7.4	39.3	364	17.6	351.5	405	-71.4	194.9
311	-11.7	39.8	365	36.2	322.6	406	-70.4	200.0
312	-18.1	40.6	366	49.6	330.5	407	-63.1	188.0
313	-20.5	40.4	367	47.3	332.0	408	-65.3	170.4
314	-23.1	42.8	368	3.6	322.9	409	-68.5	211.5
315	-27.0	47.0	369	2.9	328.8	410	-71.6	222.1

GANYMEDE

TABLE 11--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
411	-71.9	204.7	452	13.8	136.7	493	34.6	215.7
412	-66.2	214.7	453	23.1	125.1	494	43.0	219.4
413	-64.9	198.6	454	24.2	133.3	495	42.5	247.8
414	-63.7	193.2	455	25.9	141.4	496	-19.9	181.5
415	-59.3	174.1	456	50.4	186.7	497	-3.3	197.2
416	-61.1	179.3	458	46.1	159.9	500	-3.2	185.0
417	-60.0	170.3	459	51.4	169.6	501	-4.6	177.2
418	-76.5	211.9	460	27.0	134.0	502	14.6	188.1
419	-56.3	193.5	461	29.3	128.1	503	13.2	176.6
420	-71.3	156.2	462	1.2	138.0	504	15.5	180.1
421	-70.4	160.0	463	-9.8	157.0	505	47.4	227.3
422	-71.4	164.3	464	-59.5	157.2	506	43.3	201.8
423	-73.4	166.2	465	-56.7	152.3	507	32.8	193.8
424	-73.7	155.1	466	-57.0	149.6	508	35.5	178.3
425	-75.7	168.7	467	-62.1	146.7	509	45.6	183.7
426	-75.4	149.7	468	-61.1	139.4	510	-16.5	233.0
427	-79.4	210.2	469	-62.1	139.7	511	-12.5	232.1
428	-78.3	228.3	470	-64.6	142.0	512	-16.6	250.4
429	-76.7	197.7	471	-69.3	116.3	513	-20.9	242.0
430	-76.9	156.2	472	-70.1	114.7	514	-20.0	252.3
431	-77.3	149.4	473	-68.3	128.9	515	-4.1	231.5
432	-81.1	169.6	474	-73.1	119.1	516	-23.2	246.9
433	-82.0	159.6	475	-31.9	131.4	517	14.8	190.4
434	-79.8	172.3	476	-32.8	129.2	518	11.8	196.2
436	-55.3	165.0	477	-34.2	129.5	519	-5.9	178.0
437	-52.4	166.7	478	29.9	115.4	520	-6.2	173.0
438	-22.6	191.2	479	23.6	111.2	521	-7.8	169.4
439	-25.4	194.7	480	44.3	108.7	522	-7.4	166.3
440	-29.6	191.9	481	-2.0	203.5	523	-6.7	162.1
441	-29.9	173.1	482	-18.6	202.6	524	10.4	166.2
442	-35.1	191.0	483	-18.9	200.2	525	19.3	153.6
443	-23.0	174.6	484	-4.8	201.2	526	3.4	152.3
444	-65.4	163.1	485	-1.0	220.2	527	10.5	154.0
445	-64.8	143.7	486	16.8	206.8	528	-24.5	156.6
446	-66.7	141.2	487	20.7	226.3	529	-27.9	155.7
447	-17.9	112.1	488	1.1	198.3	530	-29.5	157.9
448	-6.5	112.2	489	-0.4	198.4	531	-34.8	155.2
449	-35.7	112.9	490	25.8	209.4	532	-31.1	151.9
450	-45.9	137.9	491	27.6	203.3	533	-22.4	164.9
451	12.7	130.8	492	37.2	231.3	534	-27.5	167.6

GANYMEDAE

TABLE 11--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
535	-27.5	163.4	577	1.2	212.3	621	-37.3	324.2
536	-31.6	163.5	579	-20.2	187.1	622	-42.7	329.8
537	-39.6	149.3	580	-61.1	127.8	623	-42.3	329.2
538	-40.5	146.0	581	-64.6	125.4	624	17.5	327.2
539	-41.3	139.4	582	-59.5	130.7	625	13.3	327.1
540	-39.2	156.6	583	-19.2	240.4	626	14.9	324.4
541	-39.8	152.8	584	-76.5	238.7	627	4.1	335.5
542	-37.0	159.9	585	-15.1	185.1	628	2.5	333.2
543	-37.1	163.1	586	-15.9	197.7	629	7.1	334.0
544	-43.6	157.5	587	9.9	229.4	630	-0.3	335.1
545	-42.1	155.3	589	21.1	229.4	631	-0.3	335.4
546	-46.6	155.6	590	21.0	216.8	632	14.4	0.9
547	-38.9	140.3	591	-25.4	217.4	633	16.9	354.1
548	-40.6	146.0	592	28.8	231.6	634	33.2	326.8
549	-43.6	144.7	593	-21.9	187.5	635	38.5	348.7
550	-46.1	144.2	594	11.0	329.2	636	26.5	341.2
551	-33.5	159.1	595	6.8	325.6	637	25.4	344.9
553	-48.8	173.8	596	9.8	320.4	638	23.2	347.1
554	47.6	216.4	597	14.3	314.6	639	32.0	315.4
555	47.0	242.1	598	-15.5	324.0	640	38.6	310.8
556	43.0	236.5	599	-13.4	319.9	641	35.9	320.2
557	41.9	236.1	600	-14.1	315.4	642	20.4	330.6
558	-14.8	198.4	603	2.5	311.7	643	37.2	325.2
559	-14.9	203.4	604	1.4	320.1	644	27.5	326.8
560	-20.0	188.0	605	0.8	320.7	645	3.5	316.8
561	-20.3	197.1	606	-15.4	329.3	646	52.0	316.2
562	-31.7	193.7	607	-13.5	328.1	647	49.7	322.3
563	-33.3	188.4	608	-16.9	331.2	648	74.7	16.5
564	-37.9	155.5	609	-14.3	332.8	649	74.3	358.0
565	-40.8	188.1	610	-17.8	334.0	650	59.6	54.3
566	-38.3	183.7	611	-20.9	334.3	653	-2.5	339.5
567	-28.9	177.4	612	-33.8	330.7	654	-18.3	338.4
569	39.7	209.1	613	-25.2	333.5	656	-41.1	345.7
570	29.3	208.9	614	-22.1	327.8	657	-35.9	346.8
571	20.6	206.3	615	-32.0	331.9	658	-29.6	350.0
572	35.4	183.5	616	-27.2	323.4	659	-27.8	15.2
573	39.5	200.7	617	-26.1	324.4	660	39.8	343.8
574	27.5	197.1	618	-32.9	318.1	661	67.8	347.9
575	25.9	180.9	619	-38.3	317.7	662	63.1	349.8
576	39.5	193.8	620	-37.4	325.0	663	62.8	359.5

GANYMEDAE

TABLE 11--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
664	63.0	339.6	715	69.0	48.3	768	15.9	129.9
665	5.2	16.4	717	56.2	351.4	769	17.4	134.2
666	19.6	338.9	719	55.7	347.2	770	17.2	137.6
667	20.2	337.1	719	57.3	343.7	771	9.8	129.6
668	20.0	341.9	721	64.8	18.7	772	10.2	131.4
669	-55.3	265.3	731	35.3	316.2	773	13.0	132.1
670	-7.9	249.2	732	-5.3	318.8	774	12.3	124.2
671	-0.2	256.5	734	-0.3	127.9	775	14.1	129.5
680	-4.4	336.4	735	-1.2	126.5	776	12.4	118.8
683	-17.9	330.7	736	-4.9	129.7	777	10.4	124.0
684	-14.9	337.5	737	2.4	126.6	778	10.8	118.8
685	-21.4	337.4	738	-7.6	128.6	779	13.3	120.5
696	-31.2	207.7	739	3.1	129.2	780	20.2	120.5
687	84.6	52.8	740	3.5	119.9	781	20.3	118.2
688	85.6	28.6	741	-0.6	129.6	792	-22.8	146.1
689	72.1	359.3	742	-0.3	123.0	793	-9.9	161.7
690	72.1	1.4	743	-0.8	119.1	794	-14.8	153.8
691	70.9	8.2	744	-6.8	123.7	795	17.8	131.3
692	62.5	356.8	745	-6.3	120.2	796	22.7	128.7
693	61.9	356.8	746	-3.8	121.0	797	25.8	122.1
694	59.1	336.1	748	1.8	120.2	798	26.4	125.5
695	54.7	334.2	749	-2.4	129.9	799	29.7	120.4
696	51.0	324.7	750	-9.8	131.1	800	27.4	127.6
697	61.5	338.3	751	-3.3	137.1	801	28.0	125.9
698	65.9	337.1	752	4.2	136.0	802	16.5	125.0
699	53.1	326.1	753	3.3	137.3	803	4.4	131.2
700	71.0	342.6	754	1.3	136.3	804	4.0	124.8
701	72.1	328.1	755	0.2	134.1	805	5.0	138.1
702	72.4	40.7	756	-1.1	139.5	806	3.2	121.3
703	72.7	41.4	757	-5.3	140.2	807	14.1	126.0
704	70.8	49.5	758	-7.9	136.4	808	1.5	128.3
705	70.5	49.0	759	3.7	132.9	809	0.5	123.0
706	70.2	45.8	760	10.1	137.2	810	14.1	119.2
707	69.6	331.0	761	9.7	134.0	811	9.9	134.1
708	79.3	343.3	762	9.5	121.1	812	-6.0	125.1
709	77.6	343.1	763	6.9	128.5	813	-6.8	118.8
710	77.6	335.0	764	10.3	130.1	814	-6.5	129.9
711	69.5	27.9	765	17.4	133.1	815	-7.6	132.5
713	67.6	47.2	766	-24.9	119.7	816	-8.7	124.5
714	63.4	46.7	767	0.4	117.9	817	-9.9	127.3

GANYMEDAE

TABLE 11--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
809	-5.1	122.2	850	54.1	176.7	891	37.4	147.7
810	-9.3	120.2	851	38.1	166.9	892	34.2	154.6
811	-12.7	116.7	852	35.3	170.2	893	40.9	151.4
812	-19.8	117.1	853	44.7	172.3	894	25.6	136.9
813	-24.0	117.1	854	45.4	168.3	895	23.3	141.9
814	-26.0	117.5	855	25.9	170.3	896	33.0	137.0
815	-26.7	117.0	857	26.8	173.4	897	32.1	134.0
816	-21.1	116.8	858	39.9	172.2	898	15.8	143.3
817	-15.0	117.0	859	47.9	161.5	899	29.9	141.1
818	-14.1	117.9	860	40.9	159.1	900	20.1	140.9
819	-16.8	116.7	861	44.5	157.0	901	15.8	140.2
920	-14.3	120.4	862	49.2	178.7	902	11.6	139.6
821	-16.6	119.8	863	21.9	155.7	903	20.1	125.1
822	-13.3	121.7	864	19.4	160.0	904	19.1	146.3
923	-17.5	121.9	865	26.0	133.9	905	11.0	127.6
824	-14.9	119.3	866	38.6	181.4	906	11.8	132.3
825	-15.7	123.4	867	31.6	173.6	907	23.1	149.5
826	-17.3	126.6	868	28.8	184.0	908	9.5	163.8
827	-16.3	126.1	869	24.6	174.5	909	7.4	163.9
928	-14.3	125.2	870	31.5	179.1	910	7.0	151.0
829	-15.1	126.8	871	32.9	189.7	911	16.9	152.1
930	1.0	131.6	872	16.0	182.9	912	12.4	151.8
831	-16.8	117.9	873	19.0	177.8	913	5.1	153.8
832	-17.5	117.8	874	12.6	179.6	914	16.9	146.9
833	-18.7	120.6	875	22.0	183.5	915	11.9	147.5
834	-8.8	117.4	876	42.5	184.6	916	10.5	145.6
935	-7.9	122.1	877	31.2	181.8	917	6.9	166.9
836	-11.8	119.5	878	12.8	164.6	918	7.6	160.5
837	-5.9	119.4	879	15.5	164.4	919	3.6	157.5
938	-13.1	120.8	880	23.6	166.6	920	6.3	157.9
839	0.7	125.7	881	25.5	163.8	921	8.9	163.6
840	-18.5	123.2	882	12.1	168.7	922	13.5	134.3
842	15.0	117.4	883	16.6	168.2	923	-20.7	122.6
943	-71.3	177.5	884	20.4	165.5	924	-22.0	126.2
844	-69.3	174.3	885	24.3	157.7	925	3.8	148.3
845	-75.5	186.7	886	22.0	151.7	926	-5.2	144.9
946	-76.2	189.9	887	15.3	149.8	927	-4.2	146.3
847	-79.8	200.5	888	20.7	146.5	928	-10.2	146.4
848	-77.6	190.3	889	25.9	149.0	929	-6.6	146.5
849	-63.3	169.0	890	15.8	156.7	930	-13.2	147.1

GANYMEDE

TABLE 11--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
931	-18.5	154.8	971	42.9	155.7	1015	40.9	132.3
932	-21.6	145.4	974	56.9	161.9	1016	48.9	122.2
933	-16.5	147.4	976	43.1	165.3	1017	37.3	135.2
934	-24.7	145.1	977	55.9	129.9	1019	41.6	121.5
935	-24.8	147.2	978	53.6	130.8	1019	45.1	129.3
936	-26.8	145.8	979	53.3	142.4	1020	31.1	128.3
937	-16.6	144.0	980	51.1	140.3	1021	48.0	117.3
938	-19.5	145.3	982	44.6	140.2	1022	49.5	156.5
939	-27.1	148.6	983	52.1	126.0	1023	26.3	159.2
940	-23.2	153.0	984	55.9	123.7	1024	12.1	135.4
941	-25.8	162.1	985	42.9	135.3	1025	30.7	150.0
942	-16.4	161.3	986	37.4	139.1	1026	-39.6	135.4
943	-12.5	152.7	987	45.0	149.8	1027	-39.9	132.4
944	-12.4	153.7	988	47.1	145.2	1028	-39.7	128.8
945	-21.3	162.4	989	32.7	150.7	1029	-41.3	132.0
946	-26.4	151.8	990	36.2	126.3	1030	-41.2	134.7
947	-14.0	160.0	991	-17.3	133.5	1031	-39.9	124.7
948	-16.9	153.2	992	-17.6	148.9	1032	-40.5	121.5
949	-20.3	159.6	993	-11.1	144.5	1033	-24.6	136.9
950	-17.4	129.7	994	0.6	149.6	1034	-24.4	133.0
951	-19.3	130.0	995	-2.6	152.4	1035	-24.1	130.0
952	-21.3	121.9	996	-1.9	156.3	1036	-28.2	130.6
953	-16.1	123.8	997	-1.1	145.5	1037	-34.3	130.9
954	-19.4	123.8	998	4.4	143.6	1038	-32.9	137.1
955	-18.3	140.9	999	-2.0	158.8	1039	-28.2	136.9
956	-17.5	139.3	1000	-2.8	123.0	1040	-30.4	133.9
957	-15.8	142.0	1001	-11.8	154.9	1041	-30.2	129.6
958	-23.6	140.6	1002	-11.2	148.6	1042	-35.1	134.9
959	-30.6	147.5	1003	-18.0	158.6	1043	-32.2	142.8
960	-32.3	144.7	1004	-10.2	160.1	1044	-33.2	140.9
961	-26.3	142.1	1005	-23.6	160.2	1045	-24.7	128.7
962	-29.3	140.1	1006	-6.8	159.3	1046	-24.1	125.9
963	-23.2	139.7	1007	0.9	159.9	1047	-24.8	123.2
964	-31.1	139.2	1008	-4.4	162.2	1048	-27.1	129.2
965	-25.7	139.8	1009	-9.1	160.8	1049	-26.9	124.2
966	-20.7	139.2	1010	-16.5	149.6	1050	-32.8	135.0
967	56.2	155.1	1011	-26.5	155.6	1051	-31.5	126.5
968	36.4	143.8	1012	40.1	129.9	1052	-31.7	122.2
969	39.0	119.3	1013	35.8	123.5	1053	-33.3	124.8
970	40.6	148.6	1014	35.0	131.5	1054	-30.5	123.9

GANYMEDAE

TABLE 11—Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
1055	-35.6	125.0	1096	-50.5	132.1	1141	-56.1	157.5
1056	-23.4	128.0	1097	-57.4	140.1	1142	-56.3	142.8
1058	-27.1	127.9	1098	-58.1	143.8	1143	-56.0	150.9
1059	-35.4	127.8	1099	-63.3	135.9	1144	-57.3	144.8
1060	-23.5	134.2	1100	-68.2	137.2	1145	-51.8	146.3
1061	-35.1	141.9	1101	-69.4	136.5	1146	-54.3	149.0
1062	-38.6	140.0	1102	-66.6	135.4	1147	-53.6	147.0
1063	-32.6	131.4	1103	-69.2	136.4	1148	-49.9	142.6
1064	-32.2	138.5	1106	-66.6	124.9	1149	-51.1	139.1
1065	-34.4	136.6	1107	-70.8	131.1	1150	-53.6	144.0
1066	-39.5	143.5	1108	-70.5	134.4	1152	-45.3	158.6
1067	-41.2	141.2	1109	-65.4	147.0	1153	-50.6	156.5
1068	-26.8	132.0	1110	-69.9	122.5	1154	-51.4	159.2
1069	-37.4	133.5	1111	-66.2	131.2	1155	-46.3	151.9
1070	-33.8	130.9	1112	-66.1	136.3	1156	-55.5	139.9
1071	-36.4	150.9	1113	-67.9	140.5	1157	-57.1	136.8
1072	-38.5	136.9	1114	-67.3	129.3	1158	-50.1	147.4
1073	-41.0	141.4	1115	-67.9	149.9	1159	-46.3	140.3
1074	-47.1	144.4	1116	-68.6	123.8	1160	-52.2	139.9
1075	-48.5	147.5	1117	-68.4	146.7	1161	-57.4	142.1
1076	-48.3	141.1	1118	-71.1	142.3	1162	-55.8	147.5
1077	-49.0	138.2	1120	-71.0	126.7	1163	-66.5	146.6
1078	-46.9	136.9	1121	-69.9	129.4	1164	-66.5	155.7
1079	-47.2	149.2	1122	-73.5	152.1	1165	-61.1	155.6
1080	-45.4	147.2	1123	-74.4	145.4	1166	-62.3	150.5
1081	-41.8	127.0	1124	-75.7	139.0	1169	-60.6	149.2
1082	-51.6	144.2	1125	-65.2	150.5	1170	-66.7	158.7
1083	-54.2	140.1	1126	-71.5	146.5	1171	-54.4	149.7
1084	-55.6	145.6	1127	-69.8	152.0	1172	-54.7	142.4
1085	-49.9	130.1	1128	-79.8	140.7	1173	-66.5	143.9
1086	-46.6	133.7	1129	-75.4	158.9	1174	-73.3	138.5
1087	-47.0	130.6	1130	-76.1	163.0	1175	-62.7	143.9
1088	-49.0	131.5	1131	-78.3	168.4	1176	-59.5	143.3
1089	-51.2	133.0	1132	-77.3	136.1	1177	-73.2	150.6
1090	-46.9	133.0	1133	-79.5	149.7	1179	-70.1	149.4
1091	-54.0	129.8	1134	-77.6	143.4	1180	-68.4	141.4
1092	-47.2	128.2	1135	-78.9	123.4	1181	-47.3	141.8
1093	-43.9	125.0	1138	-54.7	156.8	1182	-48.0	143.3
1094	-51.8	127.4	1139	-55.1	153.1	1183	-47.0	146.8
1095	-47.4	121.0	1140	-56.2	155.7	1184	-45.0	151.1

GANYMEDE

TABLE 11—Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
1185	-64.0	153.2	1227	-65.3	118.5	1368	-67.8	126.8
1186	-48.1	134.6	1228	-67.3	139.5	1369	-79.0	119.0
1187	-47.3	141.9	1229	-70.0	140.4	1370	-79.6	125.5
1189	-48.9	144.6	1330	-69.5	120.1	1371	-58.5	131.5
1190	-47.6	133.3	1331	-71.3	117.6	1372	-73.7	132.1
1191	-49.5	133.8	1332	-69.3	126.2	1373	-72.1	136.4
1192	-55.2	132.3	1333	-58.3	118.4	1374	-71.6	140.4
1193	-40.3	139.5	1334	-59.6	119.7	1375	-72.3	140.2
1194	-39.4	130.3	1335	-58.8	116.9	1376	-74.4	140.4
1195	-39.9	143.6	1336	-58.1	115.8	1377	-59.4	141.0
1196	-60.4	123.1	1337	-50.0	124.6	1378	-56.9	133.1
1197	-62.1	123.6	1338	-50.7	124.5	1379	-55.2	134.7
1198	-60.1	124.3	1339	-51.8	124.8	1380	-53.9	135.0
1199	-61.6	120.5	1340	-58.6	134.7	1381	-63.8	139.7
1200	-59.7	125.6	1341	-60.7	143.3	1382	-59.7	139.6
1201	53.9	163.5	1342	-58.3	129.0	1383	-39.7	150.1
1202	43.3	164.5	1343	-47.2	123.9	1384	-36.7	147.9
1203	39.2	157.4	1344	-49.8	128.6	1385	-41.6	143.4
1204	37.1	157.4	1345	-47.8	126.5	1386	-38.7	144.5
1205	9.3	166.9	1346	-45.0	119.3	1387	-39.9	149.9
1206	11.2	170.9	1348	-51.2	121.7	1388	-36.6	144.7
1207	11.4	175.3	1349	-50.6	119.6	1389	-37.4	153.2
1208	-8.2	162.0	1350	-50.6	117.1	1390	-35.6	152.9
1209	-8.4	159.8	1351	-47.8	120.2	1391	-37.6	141.1
1210	-3.7	136.7	1352	-49.7	118.8	1392	-31.0	141.5
1211	-3.8	138.2	1353	-50.0	120.0	1393	-33.7	143.2
1212	-3.3	143.4	1354	-50.5	127.1	1394	-52.4	131.4
1214	-58.9	130.6	1355	-47.0	135.2	1395	-44.3	133.2
1215	-59.0	123.5	1356	-47.8	130.4	1396	-42.7	132.6
1216	-58.4	122.3	1357	-63.6	113.9	1397	-44.7	131.0
1217	-63.3	121.9	1358	-74.1	127.0	1398	-42.8	130.4
1218	-64.3	121.7	1359	-72.4	124.9	1399	-40.4	133.6
1219	-66.3	118.4	1360	-75.5	125.7	1400	-25.7	126.4
1220	-62.5	120.2	1361	-74.0	120.3	1401	-23.9	124.0
1221	-65.7	120.6	1362	-75.3	119.6	1402	-33.7	123.1
1222	-68.8	118.9	1363	-76.9	126.3	1403	-33.3	127.9
1223	-66.6	128.4	1364	-77.3	120.2	1404	-35.0	132.4
1224	-69.5	144.2	1365	-79.8	118.7	1405	-31.0	132.3
1225	-68.0	118.6	1366	-71.2	130.4	1406	-31.9	123.5
1226	-61.5	124.7	1367	-71.8	123.2	1407	-31.1	136.0

GANYMEDE

TABLE 11—Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
1408	-29.6	136.1	1450	-74.7	194.4	1495	-68.0	288.2
1409	-33.9	139.5	1451	-74.5	202.1	1496	-73.5	295.5
1410	-31.1	129.4	1452	-75.2	181.9	1497	-81.9	210.2
1411	-33.7	128.9	1453	-73.3	192.5	1498	-70.1	265.4
1412	-77.5	221.6	1454	-70.1	194.9	1499	-77.9	205.2
1413	-73.8	255.2	1455	-72.7	197.6	1500	-71.1	296.2
1414	-73.6	263.9	1456	-77.3	162.9	1501	-67.4	294.4
1415	-76.5	275.0	1457	-65.0	179.1	1502	-62.3	298.1
1416	-76.1	270.1	1458	-63.7	181.0	1503	-55.4	127.2
1417	-79.2	267.4	1459	-80.8	159.0	1504	-56.9	122.5
1418	-76.9	278.5	1460	-83.1	122.8	1505	-26.2	178.6
1419	-77.4	270.5	1461	-83.8	150.4	1506	-29.6	168.1
1420	-76.6	256.4	1462	-82.0	141.8	1507	-30.6	165.5
1421	-75.1	266.6	1463	-90.5	133.9	1508	-32.2	169.3
1422	-71.2	279.9	1466	-72.5	218.4	1509	-31.9	171.1
1423	-66.8	279.6	1467	-72.9	211.1	1510	-33.3	164.4
1424	-69.5	265.5	1468	-72.9	225.4	1511	-26.2	165.3
1425	-62.3	285.1	1469	-76.0	220.1	1512	-27.9	166.6
1426	-67.5	286.0	1470	-75.1	228.0	1513	-34.0	167.0
1427	-64.9	265.2	1471	-76.7	232.8	1514	-25.6	167.0
1428	-63.3	281.9	1472	-71.2	229.8	1515	-32.0	159.1
1429	-72.8	257.2	1473	-74.2	215.5	1516	-34.8	159.5
1430	-76.9	287.2	1474	-70.3	228.6	1517	-23.2	161.2
1431	-73.9	279.7	1475	-68.3	223.6	1518	-26.5	169.4
1432	-72.2	285.7	1476	-78.5	182.4	1519	-48.3	159.4
1433	-76.7	282.2	1477	-79.1	194.5	1520	-48.8	156.3
1434	-59.9	290.8	1479	-85.9	231.4	1521	-49.5	154.1
1435	-74.4	283.9	1480	-84.4	243.3	1522	-52.4	155.2
1436	-74.0	294.4	1491	-86.0	209.2	1523	-43.3	155.2
1437	-74.4	265.0	1482	-85.1	246.9	1524	-43.0	173.5
1438	-62.5	293.9	1493	-84.9	264.9	1525	-41.4	153.1
1440	-71.4	158.9	1484	-84.5	255.3	1526	-40.6	149.7
1441	-75.5	173.8	1485	-83.6	251.0	1527	-40.2	157.6
1443	-71.9	169.9	1486	-83.2	237.6	1528	-20.9	173.4
1444	-68.7	160.6	1487	-84.7	205.7	1529	-17.9	183.3
1445	-64.9	175.0	1499	-79.1	176.4	1530	-20.9	156.0
1446	-63.4	177.5	1489	-80.3	163.6	1531	-22.1	186.4
1447	-62.2	171.3	1490	-87.3	217.8	1532	-23.2	187.7
1448	-72.5	197.9	1491	-87.5	257.7	1533	-29.4	178.3
1449	-71.0	192.4	1493	-60.6	295.0	1534	-20.6	177.6

GANYMDE

TABLE 11--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
1535	-30.7	182.2	1581	-61.6	291.9	1631	-50.4	162.5
1536	-21.3	171.1	1582	-65.9	275.5	1632	-1.9	212.5
1537	-20.3	191.9	1583	-68.2	276.7	1633	-9.3	217.2
1538	-39.9	172.4	1584	-64.4	279.5	1634	-10.9	212.3
1539	-43.6	185.0	1585	-62.3	291.9	1638	0.1	326.3
1540	-44.3	172.7	1586	-68.8	268.8	1639	-9.2	324.7
1541	-51.2	148.8	1587	-71.8	267.8	1640	-21.5	318.3
1542	-47.4	152.3	1590	-67.0	265.9	1641	-34.1	342.2
1543	-49.2	149.9	1591	-75.3	275.6	1642	-34.7	335.2
1544	-39.6	143.6	1598	-24.0	168.9	1643	20.4	68.4
1546	-43.6	137.5	1599	-27.9	170.0	1644	-56.4	337.9
1547	-44.9	136.1	1600	-26.1	169.3	1649	-53.1	316.3
1548	-68.2	169.0	1601	-21.5	168.3	1651	-48.2	319.3
1549	-19.9	175.3	1602	-38.1	164.6	1652	-51.2	323.3
1550	-25.2	174.1	1603	-35.9	169.8	1653	-53.4	317.1
1551	-16.7	197.7	1604	-49.1	166.0	1654	-56.2	329.0
1552	-11.3	202.0	1605	-51.1	170.9	1655	-56.4	330.3
1553	-12.2	201.0	1606	-52.5	164.0	1656	-55.7	3.8
1554	-17.3	197.6	1607	-50.8	177.3	1658	-65.2	18.7
1556	-18.8	193.8	1608	-51.9	187.7	1659	-68.2	360.5
1557	-34.9	161.3	1609	-46.7	181.7	1660	-46.0	14.9
1558	-36.8	164.7	1610	-47.3	184.9	1663	-69.7	350.3
1559	-31.7	162.6	1611	-46.2	179.4	1665	-75.4	326.5
1560	-35.5	162.6	1612	-38.2	187.8	1666	-64.9	320.8
1561	-34.9	165.4	1613	-40.1	177.8	1667	-62.1	317.1
1562	-34.4	170.7	1614	-32.3	137.7	1668	-57.7	315.1
1563	-29.3	160.2	1615	-33.1	137.8	1669	-5.3	68.1
1564	-73.0	246.6	1616	-30.8	137.4	1670	23.2	73.2
1565	-64.9	269.4	1617	-31.7	179.3	1671	29.1	42.7
1567	-63.7	274.2	1618	-38.6	183.2	1672	-25.4	58.7
1570	-65.6	254.6	1619	-34.6	183.7	1675	-20.2	330.6
1571	-73.5	236.2	1620	-41.7	177.5	2000	-9.7	21.7
1572	-73.7	239.6	1621	-31.3	185.5	2001	-22.3	17.2
1573	-71.4	244.6	1622	-42.2	191.0	2002	-17.3	26.3
1574	-68.4	249.2	1624	-29.2	152.6	2003	-11.1	13.2
1575	-67.2	253.9	1625	-36.2	192.8	2004	-19.2	4.7
1576	-70.4	253.4	1626	-41.0	193.0	2005	-13.7	5.0
1577	-69.5	256.2	1627	-37.1	173.7	2006	-6.9	12.9
1578	-72.3	250.3	1629	-41.0	171.8	2007	-7.4	3.4
1580	-66.0	272.5	1630	-38.6	165.3	2008	-29.4	38.8

GANYMEDE

TABLE 11--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
2010	-16.9	339.4	2067	-7.2	119.6	2107	-40.2	138.6
2011	-20.5	337.8	2068	-8.3	118.8	2108	-10.4	205.0
2012	-21.5	333.4	2069	3.5	195.1	3001	62.5	13.2
2013	-14.9	330.0	2070	2.2	192.9	3002	64.0	345.8
2016	-24.1	342.1	2071	-0.5	190.7	3003	56.0	359.5
2019	-2.3	353.3	2072	-7.7	197.3	3004	57.9	41.5
2020	-1.8	346.7	2073	8.7	176.5	3005	57.3	40.7
2022	1.1	344.2	2076	10.8	163.3	3006	29.5	329.0
2024	-2.2	341.7	2077	8.1	162.3	3007	24.0	331.6
2025	27.1	327.8	2079	9.1	160.5	3009	11.5	31.2
2026	26.3	323.9	2080	2.2	157.6	3010	22.7	353.4
2027	27.7	320.7	2081	0.0	157.0	3012	-6.5	20.7
2028	23.6	319.3	2092	-9.1	151.9	3013	9.7	309.2
2030	27.9	312.5	2083	-13.5	152.9	3014	-46.7	9.1
2032	7.4	320.2	2084	-13.9	146.4	3016	71.5	29.8
2035	30.1	336.9	2095	-4.6	145.1	3017	71.3	351.1
2036	33.1	336.5	2086	-10.6	141.6	3018	-70.4	267.7
2037	32.2	331.0	2097	-7.8	137.5	3019	-60.9	268.2
2038	31.2	316.4	2088	-16.4	160.7	3020	-67.7	196.5
2039	44.1	325.5	2089	-24.5	156.7	3022	-17.7	191.7
2040	47.4	317.8	2090	-33.8	154.4	3023	-37.5	164.9
2041	52.6	326.3	2091	-18.4	148.4	3024	-62.2	123.2
2042	40.7	316.1	2092	-29.4	145.4	3025	31.1	343.9
2043	36.4	332.5	2093	-9.9	164.1	3031	16.4	37.8
2044	42.8	333.7	2094	-5.8	128.6	5018	-40.9	351.0
2045	51.3	335.4	2095	-84.3	148.4	5026	-47.0	346.6
2046	26.0	334.2	2096	-83.3	136.4	5027	-52.9	349.4
2047	-13.9	321.9	2097	-77.6	210.1	5052	30.4	332.3
2049	-16.2	335.0	2098	-76.9	228.7	5110	69.6	320.3
2050	-10.7	322.3	2099	-71.8	220.2	5101	77.6	6.9
2051	-38.6	347.6	2101	-30.3	188.4	5103	80.3	342.7
2052	-17.5	348.8	2102	-4.5	180.0	5260	58.7	30.3
2053	-24.7	349.4	2103	-24.4	148.4	6136	-20.1	157.5
2056	-10.9	317.9	2104	0.5	144.9	7074	4.9	174.2
2059	-10.8	330.2	2105	29.7	161.3	7075	2.1	174.1
2060	-10.0	321.8	2106	-3.0	128.6			

TABLE 12. CALLISTO: Coordinates of Control Points

(degrees)

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
1	3.4	113.5	43	84.1	336.6	83	76.9	93.1
2	42.2	55.3	44	-22.6	316.2	94	76.9	107.0
3	26.4	126.8	45	75.7	4.4	95	79.2	101.9
4	28.4	141.9	46	67.2	323.5	86	72.3	46.8
5	6.8	90.4	47	64.5	337.7	87	69.4	120.8
6	41.5	134.5	48	65.5	322.6	88	70.3	124.5
7	5.6	165.0	49	60.0	321.5	89	65.5	126.2
8	-35.9	126.5	50	-2.5	329.3	91	37.2	36.0
9	-28.6	155.1	51	-1.5	313.9	92	68.0	68.4
10	-24.6	207.6	52	-33.3	331.0	93	57.8	105.1
11	-0.8	248.1	53	79.2	323.3	94	37.2	70.5
12	41.2	213.5	54	83.1	79.9	95	39.6	70.7
14	26.7	186.9	55	82.3	53.2	96	40.0	76.3
15	53.1	223.3	56	94.0	40.1	97	41.6	77.0
16	9.0	209.0	57	62.8	108.1	98	59.2	80.9
17	7.3	224.1	58	63.9	102.2	100	31.6	85.1
19	-11.2	290.6	59	66.9	96.6	101	47.5	80.2
19	10.1	276.9	60	67.5	90.7	103	47.1	95.5
20	49.9	243.4	61	64.9	84.9	104	25.6	85.4
21	-47.2	268.7	62	71.8	352.5	105	24.0	85.5
22	-50.0	251.2	63	74.1	25.3	106	25.1	91.1
23	-21.6	315.6	64	75.6	20.2	108	-25.5	51.1
24	6.6	314.7	65	68.4	18.6	109	-26.8	29.5
25	17.3	296.7	66	69.1	349.9	110	51.1	328.7
26	-21.3	339.3	67	63.7	358.3	111	49.2	325.3
27	25.0	350.4	68	52.2	349.4	112	44.6	330.5
28	43.9	358.8	69	57.9	338.7	113	48.7	323.2
29	-9.1	27.6	70	0.5	31.9	114	34.8	325.1
30	43.3	39.2	71	16.6	56.9	115	26.4	321.5
31	-48.6	1.4	72	4.4	14.8	116	45.5	321.1
32	11.6	31.7	73	20.3	10.5	117	43.7	46.4
34	-2.7	343.1	74	6.4	5.7	118	47.6	43.9
35	29.3	19.1	75	5.5	38.5	119	50.2	37.8
36	21.3	39.4	76	13.7	65.3	120	50.4	22.4
37	34.5	36.1	77	10.5	65.4	121	70.5	337.1
38	67.3	0.2	78	35.1	62.0	122	48.3	97.4
39	63.1	330.0	79	32.8	54.3	123	27.8	109.8
40	75.4	323.0	80	40.9	56.8	124	36.3	118.4
41	24.9	315.0	81	71.2	82.3	125	62.9	123.9
42	21.4	314.0	82	72.0	73.5	126	53.8	121.0

CALLISTO

TABLE 12--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
127	51.9	120.6	174	38.4	25.3	214	48.2	7.6
129	42.4	118.7	175	-2.6	53.6	215	59.6	23.3
129	41.3	114.1	176	6.9	25.6	216	55.4	16.2
130	44.3	109.7	177	15.9	4.4	217	52.8	12.9
131	46.2	133.4	178	13.8	336.5	218	47.4	2.5
132	52.2	132.5	179	16.5	348.5	219	55.8	20.5
133	28.8	135.9	190	-18.3	354.1	220	62.9	38.0
134	31.3	133.4	181	-2.1	355.7	221	58.1	25.9
135	37.2	134.3	182	20.0	333.0	222	45.7	100.6
136	-5.5	37.1	183	-18.4	331.6	223	52.7	78.0
137	-4.5	42.8	194	-30.9	357.3	224	49.5	98.5
138	64.4	49.3	185	-23.6	1.9	225	41.9	103.2
139	62.4	48.2	186	-29.1	10.5	226	31.7	111.7
140	60.7	35.2	197	3.4	69.1	227	5.9	3.5
141	39.8	17.8	188	22.3	69.6	228	22.7	20.3
142	42.9	4.2	189	46.8	67.0	229	27.9	23.9
143	34.1	1.9	190	-12.9	58.2	230	32.3	24.4
144	25.0	9.7	191	12.7	39.5	231	38.4	43.7
145	17.7	15.4	192	22.6	44.5	232	36.5	39.5
146	0.3	5.6	193	47.2	335.9	233	39.4	54.6
147	-4.1	5.4	194	35.2	357.7	234	41.1	64.6
148	11.1	355.8	195	45.6	315.7	235	56.4	56.5
149	20.5	349.0	196	11.2	359.4	236	51.6	56.1
150	4.2	354.4	197	12.7	318.5	237	35.2	81.9
158	28.4	16.3	198	25.2	325.5	238	-8.7	19.7
159	20.5	20.6	199	12.4	324.2	239	-14.9	20.5
160	21.2	23.2	200	29.2	322.8	240	3.2	36.4
161	55.4	31.8	201	36.8	327.2	241	13.3	52.2
162	44.0	17.0	202	27.9	327.2	242	3.0	333.5
163	34.2	10.9	203	52.0	330.9	243	1.1	342.8
164	49.9	1.9	204	57.2	334.7	244	-6.9	349.8
165	62.2	16.6	205	64.3	334.3	245	33.2	240.4
166	79.8	58.9	206	76.2	353.5	246	31.2	235.4
167	60.6	8.5	207	64.3	341.0	247	35.2	264.3
168	42.8	331.1	208	76.1	81.6	248	30.5	256.2
169	37.7	333.7	209	71.6	103.6	249	58.6	202.1
170	24.7	340.9	210	66.5	114.1	250	49.4	227.1
171	0.6	62.3	211	36.1	354.3	251	14.1	196.7
172	27.9	41.1	212	31.2	353.1	252	22.1	216.5
173	11.2	11.3	213	44.3	0.2	253	10.1	246.3

CALLISTO

TABLE 12--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
254	1.1	253.1	294	60.4	237.4	335	-33.1	26.5
255	17.8	266.7	295	37.8	158.1	336	-25.3	24.2
256	8.6	268.6	296	49.4	176.5	337	-15.2	24.2
257	-2.5	222.2	297	29.1	175.1	338	-6.3	14.2
258	-4.7	231.6	298	-5.5	37.8	339	-7.3	4.8
259	-8.4	251.5	299	-17.0	36.8	340	-8.2	346.9
260	-25.6	255.4	300	-0.4	36.3	341	10.0	353.5
261	53.9	266.9	301	6.1	251.4	342	27.8	348.1
262	47.5	263.4	302	-3.5	250.6	343	27.9	342.4
263	80.9	237.3	303	-13.1	255.8	344	15.0	44.7
264	39.9	232.7	304	-20.9	254.5	345	-10.1	332.6
265	45.0	226.8	305	-20.5	259.2	346	52.2	349.5
266	53.3	205.5	307	-17.2	270.9	347	35.7	349.9
267	35.3	206.2	308	-22.7	264.6	348	2.1	51.9
268	28.7	200.0	309	-8.6	261.9	349	-0.8	46.2
269	22.5	269.7	310	1.2	266.0	350	3.6	338.4
270	27.4	268.6	311	5.5	257.5	351	-38.7	5.2
271	18.7	255.3	312	9.3	241.8	354	-26.1	338.4
272	12.9	235.4	313	19.7	236.2	355	-16.8	338.2
273	17.8	228.5	314	25.0	234.4	356	-26.5	324.2
274	5.2	244.5	315	28.3	231.9	357	-32.7	19.2
275	-3.2	273.6	316	33.9	237.0	359	-18.5	31.4
276	-17.2	248.9	317	26.4	222.9	361	-16.1	3.1
277	-23.3	237.4	318	18.9	206.1	363	-11.5	358.8
278	-30.4	256.1	319	25.8	238.7	366	-1.5	334.4
279	-28.7	267.5	320	14.1	243.7	367	4.6	330.9
280	21.4	191.5	321	20.8	240.6	368	-9.5	327.0
281	33.7	190.5	322	40.5	263.1	370	-10.2	45.4
282	8.4	180.6	323	38.6	252.6	372	-13.7	34.4
283	4.5	171.9	324	-3.9	237.9	373	3.3	24.4
284	17.6	151.5	325	-14.6	223.9	375	10.1	18.5
285	-7.3	176.4	326	-18.5	215.0	377	11.6	345.3
286	-29.9	197.8	327	-18.2	209.3	378	17.2	341.9
287	-18.8	200.5	328	-12.1	213.0	379	10.7	336.2
288	-32.3	172.5	329	3.7	270.5	380	15.3	323.8
289	-45.9	211.3	330	0.6	261.6	382	-3.0	32.1
290	68.1	246.1	331	36.1	241.5	386	43.8	348.3
291	77.0	203.2	332	36.2	246.6	389	28.8	32.6
292	61.5	169.2	333	-36.1	341.0	390	17.8	26.9
293	67.3	226.3	334	-24.0	347.3	391	23.4	33.4

CALLISTO

TABLE 12--Continued

Point	Lat.	Long.	Point	Lat.	Long.	Point	Lat.	Long.
392	9.8	44.9	4010	51.8	101.5	4042	53.1	352.0
393	4.0	43.5	4011	58.8	102.0	4043	64.6	348.7
394	9.2	54.3	4012	61.8	105.3	4044	65.0	344.2
395	8.5	72.7	4013	64.9	106.3	4045	-21.9	349.8
396	43.3	340.1	4015	69.6	90.9	4046	45.4	343.3
397	50.2	339.7	4017	63.2	81.5	4047	55.8	329.1
398	57.6	359.6	4018	63.1	78.0	4048	56.5	329.9
399	40.6	9.9	4019	64.7	76.3	4050	9.7	325.4
400	0.6	326.0	4020	-15.7	56.3	4051	22.3	323.8
401	43.5	29.1	4022	45.9	52.9	4052	51.8	323.6
402	45.5	39.4	4023	59.6	56.4	4053	57.3	318.7
403	36.4	48.1	4024	63.6	53.0	4054	65.3	321.9
404	32.2	41.8	4025	-0.8	46.2	4056	-32.9	262.9
405	26.8	46.3	4026	-35.7	43.1	4058	64.1	269.3
406	29.1	59.6	4029	58.0	32.9	4059	71.9	237.9
408	30.9	69.2	4030	36.3	29.1	4061	-10.0	223.9
409	19.7	62.6	4031	56.0	25.3	4062	-4.2	215.1
411	47.2	353.0	4032	64.9	23.0	4063	71.5	225.6
4001	72.9	36.9	4034	49.6	20.1	4064	76.2	135.6
4002	64.3	68.1	4035	54.3	16.0	4065	74.3	110.9
4003	-54.2	23.6	4036	57.0	12.2	4066	77.0	77.6
4004	29.9	129.9	4037	-11.5	5.1	4067	71.9	64.3
4005	42.7	135.6	4038	18.7	5.6	4068	78.2	20.2
4006	67.7	136.5	4039	29.4	11.8	4069	80.2	348.3
4007	60.1	115.9	4040	43.6	10.9	4070	72.6	316.5
4008	66.5	121.5	4041	-3.2	358.4	4071	55.5	314.7
4009	47.2	103.3						

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